# PROGRAMMATIC HYDROLOGIC MANIPULATION ENVIRONMENTAL IMPACT STATEMENT AND APPENDIXES

## DRAFT

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## 1.0. *INTRODUCTION*

Louisiana's coastal wetlands are a disappearing landscape form. Louisiana's coastal wetlands have been disappearing, are disappearing and will continue to disappear. So, too, will the functions and values derived and associated with coastal marshes unless comprehensive corrective actions are taken.

How fast wetlands disappear is related to a suite of factors, including geologic history and processes, soil type, and the individual and interactive effects of surface activities (e.g., flood control, navigation improvement projects, oil and gas activities, wildlife management, wetland protection). Because these and other factors are not the same even within the same basin, historic loss rates and reasons differ depending upon where in the coastal zone you are. However, loss rates seem to be generally slowing (Dunbar et. al., 1990; Dunbar et. al. 1992). Although a very few areas appear to be stable or even accreting, such areas represent a departure from the likely overall trend of continued wetland losses.

Solutions to coastal erosion are wanted. The social, economic and environmental implications of wetland loss are significant. Concern for those implications is shared mutually by landowners, lease holders, land managers, resource user groups, academicians and government agencies.

Site-specific approaches to dealing with coastal erosion and marsh dependent resources are appealing and part of the answer. Landowners, leaseholders and land managers prefer to implement projects that can address marsh-related interests on a site-specific scale (e.g., lease limits, property boundaries). Site specific projects are attractive to landowners, leaseholders or land managers because costs can be controlled and the project can be designed and constructed fairly quickly and operated specifically to meet their objectives. Diversions of freshwater and/or sediments are an alternative but they typically take significantly more time to design and implement, often require the construction and maintenance of ancillary features, and generally can't be exclusively controlled by the affected land holding interests.

Typically, there is a lack of definitive/factual information and documentation about why a particular marsh has eroded and continues to erode. Knowing precisely what factors interact in what fashion to cause a specific marsh to erode is a fairly uncommon occurrence (Cahoon and Groat, eds., 1990). Thus, solutions tend to reflect some informed

guesswork or generalizations. Accordingly, people that want to implement solutions to marsh loss are forced to rely upon several sources of information to surmise the reasons for the observed erosion at a given location.

Solutions to address marsh losses typically reflect consideration of the cause(s) of erosion as well as other management objectives. Multi-purposed management efforts are popular but so too are management efforts designed to manage marsh acreages for singular purposes.

Projects to stem marsh losses on a site-specific scale typically call for some dredging, the construction of water control structures and/or the placement of dredge or fill material. Dredging, constructing water control structures and the placement of dredge or fill material are activities that, when done in wetlands or tidal waters, require Federal permits. In most instances, a state-level permit is also required and must be issued before a Federal permit can be issued.

The effectiveness of typical site specific solutions are poorly understood and seldom comprehensively documented. The impacts, individually and cumulatively, of marsh management are also poorly understood and documented. These facts were noted by Cahoon and Groat (1990). The existing information about the effects of marsh management is persuasive or conclusive on only some of the cogent aspects of marsh management (Op. Cite.), but subject to varied interpretations, or simply lacking about many others. This interpretative latitude and lack of information is largely the reason there is a dispute about what marsh management and hydrologic restoration can and can't be counted on to do. The lack of definitive insight and understanding complicates the permit decision making process because consideration of cumulative impacts is a mandated part of every permit evaluation performed for each permit requested.

Predicting future conditions of specific marshes, with or without corrective actions in place, can be done only in general terms, which reduces accuracy. This is a problem for all people interested in marshes. With little conclusive or persuasive information about many of the important aspects of marsh management, reliance upon the professional judgement and insight of the involved scientists often becomes the primary analytical approach as well as the basis for professional disagreement.

Hydrologic restoration evolved from marsh management. *Marsh management* is the management option of choice when a project's objective(s) and goal(s) probably cannot be achieved merely by emulating some historic, often natural,

hydrologic condition. A decision to employ marsh management is evidence that the manager concluded that acquiring and retaining the capability to create and control (to various degrees) the hydrologic conditions within the managed marsh is probably absolutely essential if the goals and objectives of the project are to be achieved. Structures are located, and some may be manipulated, to control when and how much water of what quality is within the managed area at any given time.

*Hydrologic restoration* is often the management option of choice when a manager's objective and goal probably can be achieved by recreating conditions that emulate some historic, often natural, hydrologic condition in the marsh targeted for management. Often structures are used to reduce the influence of erosional forces.
Requests to implement updated designs typically happen before the affects of the updated designs can be scientifically documented. Because the changes are perceived by proponents of marsh management as improvements that may minimize adverse impacts of earlier or other alternative designs for a given project, permit requests will almost always precede the availability of substantiating scientific documentation. Thus, reliance upon best professional judgement, often of anecdotal evidence, is commonly a facet of the permit decision making process.

The permit applicant is entitled to and receives a balanced decision. The permit decision making process is strongly influenced by subjective science when it comes to marsh management and hydrologic restoration. However, that subjective science, with its accompanying uncertainties, is tempered by consideration of the applicant's needs and interests as well as social and economic factors. Only when all the biologic, social and economic information needed to make a decision is assembled through the efforts of the applicant, interested parties and the Corps of Engineers and evaluated by the Corps permit manager is a permit decision made. Acquisition of the necessary information, followed by efforts to forge a mutually acceptable consensus understanding between all involved interests, have been the most time consuming stages of the permit decision making process.

The title of this document is different than was advertised in the Federal Register. The title may be different but the subject is still the same. When the Corps of Engineers - New Orleans District (NOD) published its Notice of Intent to Prepare an Environmental Impact Statement on Marsh Management, marsh management was the only term in use. However, the terminology has expanded to identify another

option for managing Louisiana's coastal marshes. That other option is hydrologic restoration. Both management options involve manipulating hydrology, and one can be an alternative to the other. Accordingly, NOD chose to address both in this document and concluded that Programmatic Hydrologic Manipulation Environmental Impact Statement (PHMIES) was a more accurate representation of the subject matter.

## 2.0. ***PURPOSE AND NEED***

### 2.1. **Corps/NOD Regulatory Permit Program**

The Corps of Engineers (Corps) has the administrative responsibility to issue Federal permits for the installation of structures and certain activities that occur within wetlands and other waters of the United States. That responsibility is vested in two Federal laws.

The River and Harbor Act of 1899, as amended, authorizes the Corps to issue permits for the installation and maintenance of structures or for dredging in navigable waters of the United States.

The Clean Water Act of 1972, as amended, authorized the Corps of Engineers to issuance permits for the placement of dredge or fill material in waters of the United States including wetlands. The Clean Water Act authorized the Environmental Protection Agency (EPA) to promulgate the 404 guidelines and oversee the Corps' administration of the permit program. Specifically, the Corps administers Section 404 of the act.

In tidal waters, dredging and placement of material to construct and/or maintain levees, the installation of weirs (wooden or rock), culverts, or gates, are examples of activities or structures that are regulated under Section 10 of the River and Harbor Act.

Placement/disposal of dreged material in wetlands to create levees or to install weirs or culverts are examples of activities that are regulated under Section 404 of the Clean Water Act.

Accordingly, actions or structures commonly associated with the installation, operation and maintenance of a marsh management project, as addressed in this programmatic EIS, have and will continue to require the issuance by the New Orleans District (NOD), Corps of one or both of the above mentioned Federal permits.

The Corps has published the rules it uses to carry out its regulatory responsibilities in the Federal Register. Those rules stipulate what the Corps is required to do for each permit decision it renders.

Regarding its general regulatory responsibilities, 18 general policies are listed. Each is addressed individually on a case-by-case permit request basis when applicable. To name a few, the Corps' rules include policies on what to consider relative to the public interest, wetlands, fish and

wildlife, water quality, historic, cultural scenic and recreational values, consideration of private ownership, activities affecting coastal zones, energy conservation and development, environmental benefits, and economics.

The public interest, briefly, requires the Corps to consider the likely individual and cumulative effects of the proposed project or action on 21 specific factors, and stipulates that a permit will be denied if the proposed action is contrary to the overall public interest.

The 404 (b)(1) Guidelines that the Corps administers were published by the EPA in the Federal Register. The Guidelines require the Corps to make a factual determination for each applicable permit case relative to the individual and cumulative effects of the proposed discharge/disposal to include direct and indirect as well as secondary and effects. In order for the Corps to issue a 404 permit, the proposed discharge must comply with those guidelines.

## 2.2. **National Environmental Policy Act (NEPA)**

Issuance of a Federal permit by NOD is a major Federal action. When the impacts of such an action can have a potential or actual significant effect on the quality of the human environment, the agency taking such action is obligated under provisions of NEPA to disclose the nature of those impacts to the public. That is accomplished by the action agency preparing an environmental impact statement (EIS).

This Programmatic Hydrologic Management EIS (PHMEIS) is being prepared because the NOD believes that some impacts and effects of marsh management and hydrologic restoration are scientifically and socioeconomically controversial and, if not already, could become potentially significant in a cumulative context. The potential for significance would stem from the multiplicity of interpretations that have been advanced and can't be substantiated or refuted regarding the potential biological effects of marsh management from the existing biologically specific data sets. The social and economic controversy stems from the fact that Louisiana's marshes are a limited and declining resource for and about which multiple and conflicting user interests are competing, and definitive economic or social information pertaining to the linkages and effects of marsh management and hydrologic restoration does not exist, thereby adding an element of professional subjectivity to permit decisions. The advent of CWPPRA has increased the potentialities.

This EIS is programmatic. That means that it focuses on the effects of marsh management and hydrologic in general rather

that on a particular or specific permit request.

NOD is required by law to comprehensively consider cumulative impacts when evaluating permit requests. NOD is aware that the already permitted marsh management areas, amounting to several hundred thousand acres, in addition to areas that might be permitted in the future, might affect unmanaged portions of the Louisiana coastal zone as well as the biological resources, including man, that depend on coastal marshes for life requisite resources. These kinds of impacts are termed cumulative impacts and are addressed in this EIS.

### 2.3. **Public Curiosity**

The public in general has expressed an interest in the administrative aspects of marsh management and hydrologic restoration. Specifically, they want to know how to get a permit for something so seemingly beneficial as marsh management or hydrologic restoration and why it seems to take so long. Thus, how NOD and the other agencies perceive marsh management and hydrologic restoration, evaluate requests for permits and what is or isn't looked upon as a permittable activity or structure is of interest in a general sense but also of value to perspective applicants for permits to carry out action or activities related to marsh management. This aspect is important because of the current and likely continued interest in the Coastal Wetlands, Planning, Protection and Restoration Act (CWPPRA). It is a joint planning and funding initiative by the Federal and state governments to help stem the erosion of coastal wetlands, which the passage of CWPPRA recognizes is a significant national resource.

# 3.0. ***ALTERNATIVES***

## 3.1. **Perspective**

Prior to the 1990's, marsh and wildlife managers employed one of two strategies to control the hydrology of a targeted marsh. Both were recognized as marsh management efforts. The ultimate purpose for undertaking either management effort nearly always was to improve habitat conditions for a few marsh dependent species that were either trapped or hunted.

One strategy reduced the chances that submerged aquatic vegetation would dry out prior to or during the waterfowl hunting season and facilitated boat movements during hunting and trapping seasons. This was accomplished by either dampening water level fluctuations or retaining minimal water levels throughout the managed marsh. When a fixed-crest was used it is termed passive marsh management. The other strategy was more encompassing in its scope. Although it, too, preserved boat movements throughout the managed area, it focused more on expanding the extent of submerged aquatic vegetation and increasing as much as possible the amount of marsh substrate vegetated with plants, especially species attractive to waterfowl and furbearers. To be successful, the manager had to dampen, or in some cases decouple the targeted marsh from, the characteristic rhythms, dynamics and chemistry of the surrounding system. In that way the manager could maintain a specific water level-water chemistry-marsh substrates relationship year after year in the targeted marsh.

One approach was to affect the hydrology of a targeted marsh system {open or semi-impounded (Herke )} primarily by using weirs with fixed-crest elevations to seasonally retain water (i.e., *passive management*). The other approach was to create a marsh system within which water levels could be lowered and/or manipulated with adjustable water control structures (i.e., *active marsh management)*.

Beginning in 1990, the CWPPRA process provided formal recognition of a newly emerging strategy termed *hydrologic restoration*. As with other management approaches, management objective(s) still dictated where structures should be located, what their role would be relative to the overall plan and to what degree they had to be manipulated. However, with the new approach deliberate attempts were made in most cases to ensure that the targeted marsh communicated with and responded largely in synchrony with the rhythms, dynamics and chemistry of the surrounding system but in a fashion that mimics a historic, often natural, situation.

Consequently, proponents of this form of marsh management purport it to be less impact intensive. The term *hydrologic restoration* came into common usage during CWPPRA to identify this new approach. However, some previously permitted "marsh management" projects could be more correctly characterized as early hydrologic restoration projects.

## 3.2 **Alternatives**

This programmatic EIS touches upon all three marsh management approaches in various ways. Some effects are directly related to the structures and their effect on hydrology. But, other effects, especially social and economic and cultural, can be independent of a structure's biological effects.

### 3.2.1. No Action (Future Without Additional Management)

NEPA requires NOD to consider the implications of not taking the proposed action. Literally, that equates to NOD denying every future application for a permit requesting authorization to perform activities or to install/operate/maintain structures necessary to carry out marsh management/hydrologic restoration efforts beyond those already permitted and objectively evaluating the consequent effects. Conceptually, that equates to a determination that future proposals would either be contrary to the public interest or would fail to comply with provisions of the Clean Water Act or other applicable laws. It does not mean revoking or suspending existing permits.

Thus, the effects of this alternative are the reasonably foreseeable consequences of the continued operation and maintenance of existing permitted plans. Abandonment of a permitted project is also a possibility but is not explicitly addressed.

For the purposes of this PHMEIS permit applications received by the New Orleans District from 1977 through April 1995 for activates related to "marsh management" served as the data base.

### 3.2.2. Future With Additional Management

#### 3.2.2.1. Assumption About Source, Number and General Concept of Candidate Project Types

NOD believes CWPPRA is explicit evidence that several state and Federal agencies, as well as some members of the general public, have concluded that marsh management and hydrologic restoration have a future in coastal Louisiana. NOD does

not endorse or discount that perception. Instead, NOD views marsh management and hydrologic restoration as legitimate alternatives to each other as well as several other management options (e.g., sediment diversion, freshwater diversion) to control (principally) marsh erosion.

The general relationship between all the CWPPRA managemnent alternatives was presented in the Louisiana Coastal Wetlands Restoration Plan: Main Report and Environmental Impact Statement (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993). Thus, NOD's PHMEIS focuses only on the comparative relationship between marsh management and hydrologic restoration.

Since the CWPPRA initiative began, the number of permit applications for marsh management has generally diminished. Whatsmore, permit applications received for marsh management in the last year or two include an increasing number of CWPPRA sanctioned projects. Whatsmore, several previously permitted projects have been incorporated into and been authorized, funded and implemtned under the auspices of CWPPRA. For these reasons, the effects of this alternative are the reasonably foreseeable consequences of installing, operating, maintaining and modifying CWPPRA-derived marsh management/hydrologic restoration efforts. Accordingly, this programmatic EIS assumes that same pool is the most reasonable projection of the maximum number (by basin), longevity (20 years) and location of such projects (see basin maps in CWPRRA appendices).

#### 3.2.2.2. Assumption About Passive Management

Passive management will be addressed in this programmatic EIS but in a somewhat different context than either hydrologic restoration or marsh management. Passive management, where a fixed-crest weir is used to control the hydrology of a semi-impounded area, is rapidly becoming a relict form of marsh management and is not included as a project type in CWPPRA. Thus, the "future with" condition will focus on characterizing the effects existent passive management projects impart into the foreseeable future rather than characterizing effects of any additional passive management projects.

#### 3.2.2.3. Assumption About Marsh Management and Hydrologic Restoration Project Design Details

Many CWPPRA hydrologic restoration and marsh management projects are conceptual. For those projects, details about the number, kind, location and operational program of any installed structures would be determined during the evaluation of each individual permit request. For most of

the others, preliminary information about the kind, number and operational schemes of candidate structures is available and, for quite a few, are well enough developed to proceed to permit application submittal. However, the design and operational details of any plan's structures are preliminarily determined immediately prior to submitting a permit application and finalized when the required permit is issued.

The potential number of combinations possible when considering the number, kind, location and operational schemes of candidate structures is too large to comfortably handle even within a programmatic context. Until project designs are finalized, projections of project specific impacts have been addressed collectively and in a conceptual context based upon entries made in tables profiling previously permitted marsh management projects (1977-1995) and candidate CWPPRA marsh management and hydrologic restoration projects.

#### 3.2.2.4. Assumption About Rate of Project Implementation

In contrast to some arbitrary phased implementation rate, NOD will assume that all candidate CWPPRA projects will be installed all at once and immediately. Clearly, this is an unrealistic simplifying assumption. However, the marsh management/hydrologic restoration projects included in the CWPPRA basin plans represent incremental, typically site specific but nonetheless measurable efforts (at least qualitatively) to arrest coastal erosion and are presumed by CWPPRA to be viable candidate projects. Even if only some candidate CWPPRA plans are eventually implemented, the associated impacts would be less relative to the total potential impacts likely to result if all CWPPRA marsh management and hydrologic restoration projects were eventually implemented.

Conceptually, by assuming immediate and total implementation, we believe we minimize the potential to overestimate total impacts and effects because we do risk poorly approximating incremental impacts associated with any gradual implementation. We expect that impacts associated with implementation of each project would be accounted for during the permit evaluation process.

## 3.3. **Public Scoping Meeting Issues Addressed in This PHMEIS**

Detailed narratives are presented in the **SETTINGS** chapter of this EIS.

### 3.3.1. Social and Economic Issues

NOD **is** required to disclose and weigh the social and economic impacts and effects of a decision to issue or deny permits for regulated activities. Therefore, NOD **will** strive to fully assess the underlying social and economic implications attributable to marsh management at a programmatic level.

Notably, the following concerns exist whether or not management occurs. Management may accentuate them, and the EIS will focus on any such incremental increase.

3.3.1.1. From the Landowner/Leaseholders Viewpoint

3.3.1.1.1. Limiting Public Access

There appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

3.3.1.1.2. Vandalism and Liability

The issue is landowners feel they are unilaterally exposed to the risks and costs of vandalism and liability claims if they are forced to provide uncontrolled public access to their property or are precluded from limiting access.

3.3.1.1.3. Harvest

The primary issue is whether marsh-dependent resources (e.g., fur, fish, alligators, waterfowl) are public resources or wholly proprietary resources. The related issue is public access.

If marsh-dependent resources are proprietary, as is apparently assumed by many land owners, then the landowner, they argue, can deny access to his/her property to harvest on the basis of their being no public resource involved.

If there are public resources, then the landowner apparently feels he/she is exposed to added vandalism, trespass and liability claims if the public is allowed uncontrolled access to his/her property, the landowner is precluded from controlling access, or members of the public are enticed to trespass by the enhanced resources associated with the managed area.

3.3.1.1.4. Protecting Values Associated with Marsh Ownership

There are apparently two components to this concern: 1) preventing the loss of mineral rights/royalties; and, 2) capturing the economic values of harvestable marsh-dependent resources.

Regarding mineral rights, the issue is that under applicable state law, the state owns the mineral rights under state-owned water bottoms. Slowing or stopping the conversion of marsh to open water precludes the possibility that the state could claim ownership of that new water bottom and any underlying minerals. This is presumed to be the basic motivation for landowners/mineral rights holders to elect to manage marshes.

Regarding the monetary value of harvestable resources, the basic issue is that this represents an interest landowners wish to wholly retain but is typically a relatively minor source of potential or actual income to most landowners. To a smaller number of landowners, capturing the economic values of harvestable marsh-dependent resources is the only source of income and is, therefore, of paramount importance. Either landowner group must contend with the previously mentioned concerns of unwanted/uncontrolled access by the public, and vandalism and liability.

Management that succeeds at slowing or stopping marsh erosion benefits the mineral rights owners, furthers the missions of the Louisiana Departments of Natural Resources (Coastal Restoration Division) and LA WL&F but is counterproductive to the state revenue generating needs. This situation creates the apparent paradox that the interests of some state-level agencies could actually conflict with the interest of other state-level agencies.

3.3.1.2. From the Viewpoint of Members of the General Public Who Have an Interest in Marsh-Dependent Resources

3.3.1.2.1. Limiting Public Access

As was the case with the landowners perspectives, there appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

3.3.1.2.2. Vandalism and Liability

The issue is that public harvesters/users feel they are improperly perceived by landowners/leaseholders as a group that is generally irresponsible. They believe this is a spurious argument for controlling access.

3.3.1.2.3. Harvest

As we appreciate this issue, it has three parts: 1) public resources do not become private property simply by moving into privately owned marshes; 2) public resources, even when resident on private land, should be accessible by the public; and, 3) interfering with the free movement of

fisheries organisms between privately owned, controlled access areas and publicly accessible areas adversely effects the culture, life style and economic fortunes of many people.

Access to the resource is the principal component, but ownership of the resource is also being questioned. Both are questions of law, that need not and should not be resolved by this agency.

However, it is the social and economic effects of using structures as management tools, as they would affect access and the movement of organisms and people that is addressd in this EIS.

3.3.1.3. Small Scale Water and/or Sediment Diversion

Deliberate small-scale, typically seasonal diversions of water and/or sediment into managed areas are features of some past and future marsh management plans. They are often characterized as a phase of an actively managed area. Small diversions will be assessed in this programmatic EIS.

3.3.2. Scientific Issues

This encompasses a number of scoping meetings items.

This EIS will focus on the biologically technical questions about what has worked where to foster erosion control, to what degree, with what other biological consequences, and what alternatives there may be.

## 3.4. **Public Scoping Meeting Issues Not Addressed in This PHMEIS**

The reasons for not addressing these public scoping meeting issues in this programmatic EIS are stated.

3.4.1. Project-specific details

Particulars like specific structure designs, numbers and kinds of structures that comprise individual proposed plans, monitoring provisions, etc., are unique to each project and are properly evaluated as part of the assessment performed by NOD of each permit request. Addressing these matters in this programmatic context would be redundant, would unnecessarily and unavoidably constrain the permit evaluation process and focus on too small a scale. Therefore, those aspects of marsh management will not be discussed in detail in this EIS.

### 3.4.2. Legal

Legal proceedings are an attempt to gain administrative relief from the effects structures (and management) may have on underlying, and apparently conflicting, social and economic interests.

NOD is **not** empowered to resolve legal questions. Accordingly, NOD will **not** attempt to resolve legal questions. Neither will NOD knowingly issue a permit that conflicts with the law, nor will it attempt to anticipate where legal issues might arise in the future beyond issues brought to our attention through coordination with Louisiana State Lands and Louisiana's Attorgeny General.

However, NOD acknowledges that legal proceedings could be an indirect consequence of marsh management, and will note when legal issues have arisen based upon our experience.

The reader is asked to refer to Wilkins (1990) for an extensisve treatment of many of the legal issues surrounding marsh management.

NOD has attempted to fully assess the underlying social and economic implications of marsh management.

### 3.4.3. Independent Management Actions

When the following actions are proposed as stand-alone and complete projects, they are evaluated and may be undertaken pursuant to other permit provision established by NOD or the COE, unless otherwise noted. Therefore, they will not be assessed in this programmatic EIS.

#### 3.4.3.1. Burning

Marsh burning is a proven management practice used to adjust the composition of some marsh plant communities to favor primarily furbearers and secondarily waterfowl ( ). However, it is not regulated by either the state or the Federal government.

#### 3.4.3.2. Planting Vegetation

Planting marsh vegetation is a proven and effective form of marsh management to address wave-induced shoreline erosion and accelerate revegetation in many but not all situations( ). Whatsmore, planting vegetation <u>per se</u> is not controversial and is not regulated by either the state or the Federal government.

3.4.3.3. Site Preparation for Vegetative Plantings

However, permits may be needed from either the state and/or Federal government if preparing a site for a vegetation planting means raising the elevation of the substrate in a wetland situation (**Section 404**). Some site preparation activities for plantings, as stand-alone and complete projects, can be authorized by NOD in a general permit (**NOD-100**) specific for actions within the Louisiana Coastal Zone. Additionally, NOD holds that determining the implications of preparing a site for vegetative planting as a component of a more elaborate management plan is appropriately undertaken as part of the individual marsh management permit review process much as we would do regarding the number of structures. Therefore, adjusting elevations solely to facilitate a marsh plantings will not be addressed in this EIS.

3.4.3.4. Wave Dampening Devices

This is an effective way to site-specifically diminish shoreline erosion. It usually isn't controversial, can be installed as a complete and independent action to control erosion and typically isn't a critical element of any marsh management plan. For example, tire structures, Christmas tree cribs, and sediment fence structures are usually installed in shallow water along a specific reach of marsh or beach where the mechanical action of wind- or/and watercraft-induced waves against the shoreline cause(s) erosion. When installed in a navigable or tidal water, they require a Federal permit (Section 10), and may require a 404 permit as well. .

Applications for permits to install such devices would be evaluated for environmental impact as part of the mandatory review process.

3.4.3.5. Rehabilitation of Existing Water Control Structures

A project limited in its entirety to simply rehabilitating existing functional and serviceable water control structures when the design and function are not changed is already an authorized activity either under provisions of exisiting permits or under provisions of **(Nationwide Permit # 3)**, provided the footprint of any associated fill is not expanded beyond the limits of any previously existing filled area. This work could occur whether or not it was part of a marsh management effort.

However, as part of a new marsh management effort, it would be evaluated as a component action of the marsh management effort. Thus, rehabilitations of existing structures would

be evaluated during NOD's evaluation of the requested permit for marsh management/hydrologic restoration.

### 3.4.3.6. Large Scale, Uncontained Diversions of Water/Sediment

The typical large-scale diversion project introduces or shunts water into an open marsh system with the intent of being the principal action required to arrest the erosion of several hundred to several thousand acres of marsh. Accordingly, this is perceived as an alternative to marsh management, as was the treatment given this marsh erosion control effort in the CWPPRA programmatic EIS ( ).

Additionally, government agencies are usually involved because of the scale, expense and planning effort typically involved. If undertaken as an action of the Federal government, such projects would be reviewed for environmental impacts during the project planning process.

Manipulating how much and when water and sediment is introduced or shunted into a marsh as well as how much sediment the water carries are all hydrological factors important to marsh managers.

### 3.4.3.7. Mariculture

Mariculture is an effort to enhance the economic return from estuarine marsh dependent fisheries on a commercially profitable scale. The Louisiana Legislature has taken a position of proponency by requiring mariculture efforts be undertaken only on a limited basis and only in concert with state-approved marsh management plans.

Mariculture and marsh management involve actions or the use of structures that require permits from the Federal and/or state government. There are two forms of mariculture: 1) cage culture and 2) "ranching." Cage mariculture and management of marshes can be pursued independently and neither is a biological prerequisite of the other. Thus, linking these two actions is viewed by NOD as an independent administrative action of a state agency. Placement of the cages, however, does require a permit pursuant to **Section 10**, and would be assessed accordingly. Ranching, however, involves culturing organisms in a marsh purposefully isolated from the surrounding estuary to facilitate a mariculture operation. Although management of the marsh may occur, it is a subordinate perhaps even complimentary action. Thus, the **Section 10/404** permits that would be required to create an isolated marsh situation within which a "ranching" operation could be conducted would be subjected

to an evaluation focused on mariculture and not marsh management.

Accordingly, and evaluation of cage or "ranching" forms of mariculture will not be specifically included in this programmatic EIS.

# 4.0. ENVIRONMENTAL, SCIENTIFIC, SOCIOECONOMIC, CULTURAL AND SCIENTIFIC SETTINGS

Employing an ecosystem approach, this PHMEIS discloses the effects of management actions targeting Louisiana's coastal marshes. Accordingly, the PHMEIS identifies the demonstrated, suspected, disputed and poorly known individual and cumulative biological, cultural and socioeconomic effects of undertaking the management of Louisiana's coastal marshes.

Basic definitions are presented first (4.1.). Next comes the Socioeconomic and Cultural Setting (4.2.), an overview of Marsh Management in Louisiana (4.3.), which is followed by a discussion of the Geologic, Physical, Meteorological and Chemical Environments (4.4.). Profiles of the four Louisiana coastal marsh types are presented next (4.5.). Following that, historic and future marsh loss is examined (4.6.). The written record (4.7.), a discussion of the interface between science and society (4.8.), profiles of the Significant Resources (4.9.) and a tabular comparison of marsh management and hydrologic restoration as management options (Table 4.1) conclude this section. The reader is referred to Appendix M, a narrative comparison of many of the water control structures used for managing Louisiana's coastal wetlands.

## 4.1. **Basic Definitions**

### 4.1.1. What is Marsh?

Marshes are the product of the interaction of sunlight, temperature, water levels, water chemistry conditions, substrate compositions and elevations, and the degree of environmental variability (Gosselink, 1984).

Marsh is a wetland type visually dominated by grass-like plants, typically the most obvious feature. Marsh plants become established, grow and can be expected to sustain themselves where ever their life requisite requirements naturally occur or can be created and sustained. Marsh grasses that root in the soil and have plant parts that typically extend above the water are called emergent species.

But, shallow open water areas are included in the concept of a marsh (Chabreck 1972). Open water areas are commonly referred to as ponds. Ponds need not be tidally influenced and may only temporarily retain water. Pond plants that typically have parts that grow up to but not beyond the water surface are called submerged aquatic plants.

Whether an area is more properly called a marsh with ponds or an open water (pond) area with fragmented marsh often hinges on points of view or management philosophy rather than any established scientific measure or common understanding. For example, the Louisiana Department of Natural Resources uses a data system that classifies an area as open water if there is < 50 percent vegetative cover.

Importantly, a marsh comprised of a mix of ponds and vegetated substrates usually has more associated plants and dependent animals than an equivalently sized area of just ponds or just grass.

Because an excess or shortage of any one life requisite can stress or destroy marsh plant species to the advantage of other marsh plant species, the collection of plants that vegetate the substrate or grow in the ponds can be manipulated.

### 4.1.2. What is management?

Management is a deliberate undertaking to address an objective. Management can take many forms. Depending upon the purpose of the contemplated management effort and the prevailing environmental conditions, doing nothing at all may be a practicable management decision whereas in a different situation drastic action(s) may be required to sufficiently control environmental factors enough to elicit the desired result.

### 4.1.3. How is marsh management defined?

No universally accepted definition of marsh management exists. Chabreck (1968) noted that management was an action that should be undertaken to improve habitat for selected marsh dependent animal species. But, Cahoon and Groat (1990) offered a definition that appeared in the U.S. Department of the Interior - Minerals Management Service's (MMS) document dealing with marsh management in Louisiana. Their definition is important because it was the first modern definition developed by all the interested parties and alluded to an extended application to include controlling wetland loss. That definition of marsh management is:

> *The use of structures to manipulate local hydrology for the purpose of reducing or reversing wetland loss and/or enhancing productivity of natural renewable resources.*

Clark and Lehto (1991) reviewed several definitions and in 1993, Good and Clark cite the following definition that is included in Title 43:I.721(L) La. Admin. Code:

> *A systematic development and control plan to improve and increase biological productivity, or to minimize land loss, or to enhance recreation.*

In August of 1994, the EPA defined marsh management as follows:

> *The use of spoil banks, levees and canal plugs to surround or partially surround a discrete parcel of tidally influenced marsh in combination with the use of water control structures to modify or control hydrology to various degrees for the purpose of protecting, restoring, or enhancing vegetated wetlands and/or their functions.*

4.1.4. Implications from the definitions

The definitions oblige managers to favorably affect the vegetated landscape **or** the marsh dependent resources. Paradoxically, striking balances is an option, and reducing adverse impacts to nontargeted marsh dependent animal resources, marsh plants and marsh processes is an implied optional consideration that can't always be maximized because any such efforts need only be undertaken in so far as they don't compromise the primary management goal(s). In reality, managers often make trade-offs between marsh resources {or processes (Cahoon, 1991)} to achieve specified goals (Chabreck, 1994).

4.1.5. Marsh erosion and marsh deterioration

Erosion is a process resulting in the disappearance of marsh soils and the appearance of open water where once there was a marsh soil surface covered with vegetation. Classically, erosion can occur from subsidence (i.e., sinking of the land) followed by saltwater intrusion/waterlogging of the soils and the eventual death of the marsh plants (Nyman et al 1993b). This kind of erosion has become popularly known as "hot spots". If "hot spot" erosion occurs slowly enough, different vegetative assemblages, sometimes unlike those that originally existed, may appear from time to time prior to the ultimate demise of the marsh. Wave action where the marsh 'washes away' (shoreline erosion) is another cause. Nyman et al (1993) described another kind of marsh erosion ("internal breakup"), basically an undermining of the soil below the root zone unrelated to physiological or chemical stresses.

Some of the vegetative assemblages that may appear and disappear prior to the actual loss of the marsh soil have been referred to as eroded or deteriorated marshes. An even narrower use of the term marsh erosion refers to the situation where marsh plants, not particularly attractive to wildlife, had begun to grow and flourish on substrates that had filled-in an area that was once open water (Joanen, Pers. Comm.).

4.1.6. Synthesis

In 1968, Chabreck described marsh management as the use of certain management structures to achieve specific goals relative to marsh dependent resources. Since about 1977, the term *marsh management* has progressively taken on added meaning. Today, the same term is also used to collectively describe a set of management actions with different goals but that largely rely upon many of the same structures. Thus, the context of the term's usage can be unclear if not stipulated, which is why the term now means different things to different people.

Even updated definitions still hint at self-fulfillment and self-justification that reflects the historical context of the term. But, repetitive attempts to redefine it are clear evidence of a desire to be technically correct and to give the most comprehensive impression of what marsh management has become and what it can and can't do.

Chabreck (1994, pg 45) has perhaps captured the essences of the evolution and set the tone for the future, as evidenced in the following quotation:

> *"Marsh management is a broad term and is often used to describe activities other than management of marshes. Programs designed to manage waterfowl, fur animals, alligators, marine fisheries, freshwater fisheries, crawfish cattle and even mosquitos have been described as marsh management. However, the term, 'marsh management', when used without modifiers, should describe the manipulation of a marsh and associated water bodies in a manner that enhances growth of submergent and emergent vascular plants. Management of a marsh for resources should be defined as management for those resources and not marsh."*

NOD will probably continue to play a role in Louisiana's wetlands. As a past and probable future involved agency we offer the following perspective:

> Management actions that generally benefit native, emergent and aquatic vegetative species also tend to

impart favorable, indirect benefits to many marsh-dependent organisms often with fewer overall adverse impacts than if a specific organism is targeted.

## 4.2. The Socioeconomic And Cultural Setting - Who Is Concerned About Marsh Losses and Why

### 4.2.1. A Perspective

The perception of the functions and values of coastal marshes in general has and is undergoing change (de la Cruz 1976b). Louisiana's coastal marshes have for centuries been viewed by the original native inhabitants as a rich place to fish, hunt, harvest furs and oysters. Those exact same attributes came to define the life styles of some (Ensminger, 1989; Davis 1993b) and became the foundation of the culture for others (Davis 1993b), including those who later moved to Louisiana and came to reside in or near and derive some or all of their livelihood from the coastal marshes. Since the early 1800's until this day, marshes have been leveed and pumped (Miller 1956), rivers have been channelized and leveed to redirect flows to protect life and property and often to foster agricultural endeavors (Viosca 1928). Beginning in about the middle of the 1800's, private as well as commercial maritime and port interests began to expand in response to increasing agricultural production. Transportation by water was highly desirable. Because coastal marshes were vast and perceived to be a physical obstruction, there was little objection from any quarter to their being dredged to create navigable waterways to foster economic development. Thus began the construction of what would ultimately become an extensive web of surface waterways. The waterways were built by private, commercial and public entities to interconnect emerging points of economic activity throughout the entire coastal wetland complex and/or foster the rise of new economic activities. The vision was so clear and the initiative was so successful that portions of the web begun in the mid-1800's have been subsequently upgraded and incorporated into today's Gulf Intracoastal Waterway.

Shortly after the turn of the 20th century, petroleum and mineral extraction operations began a nearly 50 year run of unprecedented growth. During the period from the 1950's to the late 1980's, much of that growth was in coastal wetlands. Fundamental to that period of growth of the petroleum and mineral extraction industries, there occurred a new spurt of dredging of coastal marshes. Not only were miles of new surface waterways excavated to facilitate the movement of vessels, but miles upon miles of marsh were also excavated to install pipelines to transport the extracted petroleum and minerals to pump stations and processing and

shipment centers. Additionally, existing natural and manmade waterways hydrologically connected to the Gulf of Mexico were repetitively widened and deepened and new waterways were also excavated to accommodate the distribution and delivery of the extracted petroleum and mineral resources as well to accommodate the routine movement of ocean-going vessels to support emerging offshore petroleum and mineral extraction operations. Again there was little objection to this additional activity because the coastal marshes were unquestionably vast, perceived as a physical obstruction and huge sums of money were involved at private as well as public levels.

The network of manmade waterways and channelized natural waterways that exists today was both the stimulus for and response to the development of what is today a highly valued infrastructure in Louisiana's coastal wetlands. Social perceptions and attributes have changed, some willingly over the years some not. The social and scientific perceptions of today are that Louisiana's coastal marshes are highly complex, hydrologically driven natural systems. They are far more complex structurally and functionally than previously imagined. There are social and cultural values associated with Louisiana's coastal marshes that were unknown, not readily apparent or undervalued just 30 years ago.

### 4.2.2. Attributes of General Social and Economic Significance

NOD **is** required to disclose and weigh the social and economic impacts and effects of a decision to issue or deny permits for regulated activities. Therefore, NOD has attempted to fully assess the underlying social and economic implications attributable to marsh management at a programmatic level.

#### 4.2.2.1. Land Value

Marsh has and will continue to have a raw real estate value.

#### 4.2.2.2. Mineral Value

The value of the mineral resources below the marsh surface is suspected of being a compelling economic reason to be interested in marshes. Under existing state laws, water bottoms that arise as marsh erodes, as well as the underlying mineral resources, revert to state ownership. The former landowner retains the right to reclaim the land surface but not the underlying mineral rights.

#### 4.2.2.3. Marsh-dependent Resources with Socioeconomic Significance

Several hundred species are associated with Louisiana's marshes. Only a relatively few have achieved social notoriety based primarily on their associated economic and/or recreational value.

##### 4.2.2.3.1. Fisheries

The principal species are menhaden, red fish, speckled trout, crabs, oysters and brown and white shrimp. Most of these species are pursued both commercially as well as recreationally. Other fresher water and estuarine dependent species also serve valuable system functions.

Leases let by landowners to harvest those resources, either recreationally or commercially, on privately owned properties constitute another economic value of this resource. To the private landowner the finances involved generally represent a secondary source of income, and generally represent a local and state level economic value. Leaseholders may well sublease or harvest the resource themselves. In either case there is an added economic value that, once again, is generally important locally or at the state-level.

##### 4.2.2.3.2. Waterfowl

Louisiana's coastal marshes winter several million waterfowl each year from the Mississippi and Central flyways. As such, Louisiana has a well deserved reputation as a waterfowl hunters paradise.

Leases let by landowners to hunt waterfowl on privately owned properties constitute another indirect economic value of this resource. To the private landowner the finances involved generally represent a secondary source of income, and generally represent a local and state level economic value. Leaseholders may well sublease or harvest the resource themselves. In either case there is an added economic value that, once again, is generally important locally or at the state-level.

"The North American Waterfowl Management Plan (NAWMP) was signed in May 1986 by the Minister of Environment for Canada and the Secretary of the Interior for the United States. It presents a broad framework for recovery of waterfowl populations which have experience broad declines in recent years. The overall goal of the NAWMP is to promote healthy wetland ecosystems to benefit wildlife and people. It

recognizes that waterfowl are excellent indicators of wetland health and uses their population levels to set broad objectives" (Gulf Coast Joint Venture, North American Waterfowl Management Plan 1990).

The NAWMP initially designated six key areas. The coastal zones of Texas, Louisiana, Mississippi and Alabama as well as the coastal plains of Texas and Louisiana, comprise one of the areas. This Gulf Coast area focuses on overwinter habitat conditions. To facilitate implementation, this Gulf Coast area was further subdivided into geographically distinct portions. The Mississippi River Coastal Wetlands (Louisiana) and the Chenier Plain (Louisiana and Texas) are two such subdivisions, called initiatives.

The objective of the Mississippi River Coastal Wetlands (Louisiana) initiative is to overwinter 4.8 million ducks, focusing on scaup and gadwall, and 32,000 geese. Conservation measures include land acquisition (100,000 acres), restoring formerly drained pasture and crop land (40,000 acres), accelerating technical assistance, improve quality of publicly owned lands (29,000 acres), and implementation of public works projects (many already approved and awaiting funding) designed to reduce the ongoing rapid loss of waterfowl habitat as well as restore and enhance remaining wetlands. Several freshwater and sediment diversions, several marsh creations with dredged material, increased law enforcement, wetland enhancement, water management and expansion of the Water Bank are the conservation strategies to be employed. Marsh management or hydrologic restoration could be a component parts of several of those strategies.

The objective of the Chenier Plain initiative, Louisiana and Texas, is to overwinter 3.3 million ducks and 236,000 geese in Louisiana. Conservation measures include acquisition (52,000 acres in Louisiana), restoring formerly drained areas (50,000 acres total), flooding rice fields during winter (200,000 acres total), accelerate and expand public works projects to combat salt water intrusion, and increase the value of 100,000 acres (Texas and Louisiana) of public administered lands. Conservation strategies to be employed include acquisition/restoration/enhancement of management capability of publicly (Federal and state refuges) and privately-owned parcels, stepped-up enforcement, more technical assistance and acquisitions. By and large, however, marsh management or hydrologic restoration could be the management option of choice. Many of the localities specified correspond with (in whole or part) previously permitted areas and candidate CWPPRA project areas.

In coastal Louisiana permitted and presumed implemented

waterfowl management projects that encompass only fresh, intermediate and/or brackish marsh have brought 76,621 acres under management. When projects that stipulated waterfowl to be a companion purpose are included (128,700 acres) the permitted acreage for projects targeting waterfowl increases to 205,321 acres.

4.2.2.3.3. Fur and Hides

Leases let by landowners to trap on privately owned properties constitute another indirect economic value of this resource. To the private landowner the finances involved generally represent a secondary source of income, and generally represent a local and state level economic value.

Leaseholders may well sublease or trap the resource themselves. In either case there is an added economic value that, once again, is generally important locally or at the state-level.

4.2.3. Socio-economic Issues Identified at the Public Scoping Meetings

4.2.3.1. From the Landowner/Leaseholders Viewpoint

Limiting access of the public to privately-owned lands is an important issues. There appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

Landowners are also concerned about protecting values associated with marsh ownership. There are apparently two components to this concern: 1) preventing the loss of mineral rights/royalties; and, 2) capturing the economic values of harvestable marsh-dependent resources.

4.2.3.2. From the Viewpoint of Members of the General Public

As was the case with the landowners perspectives, there appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

As we appreciate this issue, it has three parts: 1) public resources do not become private property simply by moving into privately owned marshes; 2) public resources, even when resident on private land, should be accessible by the public; and, 3) interfering with the free movement of fisheries organisms between privately owned, controlled access areas and publicly accessible areas adversely effects the culture, life style and economic fortunes of many

people.

These issues are individually addressed in greater detail at the Displacement of People subject entry under the Socioeconomics heading of Significant Resources.

4.2.3.3. Small Scale Water and/or Sediment Diversion

Deliberate small-scale, typically seasonal diversions of water and/or sediment into managed areas are features of some past and future active marsh management plans. They are often characterized as a phase of an actively managed area. Small diversions that are part of a marsh management or hydrologic restoration project have been considered.

## 4.3. **Evolution of Marsh Management in Louisiana**

### 4.3.1. Why Marshes Were First Managed

Marsh was traditionally viewed as a place to fish, hunt ducks, harvest furs and oysters. Those attributes defined the life styles of some (Ensminger, 1989; Davis 1993b) and are the foundation of the culture for others (Davis 1993b).

During the first quarter of this century, the commercial harvest of furbearers and waterfowl was extremely motivating (Ensminger, 1989). The market economics sustained by commercial waterfowl hunting played an undeniably influential role in fostering the management of marsh through water level control (Ensminger, 1989). Thus, wildlife managers early on developed techniques, structures and procedures to improve marsh conditions for furbearer production and overwintering waterfowl (Chabreck 1960, 1968, 1971, 1976; Jemison and Chabreck 1962; Chabreck, Yancey and McNease 1974). Managers pursued their goal primarily by dampening selected attributes of the hydrology of the targeted marsh.

In the early 1940's, species-oriented management of Louisiana's coastal marshes became more extensive and linked to the use of water control structures to control water levels (Broussard, Undated; Cahoon and Groat, 1990).

During the 1950's and 1960's, oil and gas exploration and recovery efforts escalated and earlier Mississippi and Atchafalaya Rivers flood control project had been completed for several decades. Correlated with these events, marsh loss rates accelerated to disturbing levels (Gagliano et al 1981); Turner, 1987; Dunbar, Britsch and Kemp 1990, 1992; Britsch and Kemp 1990) and an added concern developed over mineral rights reverting to the state if marsh eroded (Wilkins and Wascom 1989). Collectively, the concerns

catalyzed design and operational refinements of management approaches, structures and operational considerations and fostered a search for solutions to slow, stop or reverse the conversion of emergent marsh to open water (Governors's Coastal Restoration Technical Committee Report 1988; Clark and Lehto 1991, Talbot and Tuttle 1992).

There also was a corresponding increase in management efforts. With previous species-oriented management successes as a guide, wildlife and marsh managers were positioned to assist in fighting marsh erosion and they did so by offering a solution that was strongly influenced by their special expertise.

By 1967, about 100,000 hectares (247,000 acres) of Louisiana's coastal wetlands were already under some form of management. Since then, about another 490,000 acres (214,000 hectares) have been permitted for some form of management. Thus, by 1986 nearly 600,000 acres of Louisiana's 2.5 million acres of coastal marshes were under some form of active management (Spicer, Clark and demond, 1986).

Even these more recent marsh management efforts were typically undertaken by landowners or leaseholders intent upon capturing the greater recreational and economic potentialities of hunting, trapping and fishing for marsh dependent animal species (Chabreck 1960, Chabreck 1994) because the perception was that if marsh-dependent species benefitted then surely the marsh in general also was benefitted.

In the late 1970's, the U.S. Department of Agriculture - Soil Conservation Service (now the National Resource Conservation Service - NRCS) mated the variable-crest weir with a culvert and flapgates. This was a landmark event that significantly expanded marsh management capabilities. When used to control water levels in hydrologically discrete areas, managers created the capability to induce and sustain artificially controlled environments. The hydrologic conditions within a managed area could be manipulated pretty much independently of the seasonal water level and chemistry rhythms and dynamics of the estuary. With the capability to create controlled environments, managers could then affect how much of what kinds of plant species could be induced to grow in the managed area. They reasoned that water levels could be drawn down to and subsequently maintained at specified levels relative to the level of the marsh surface or pond bottoms by configuring water control structures to only allow the movement of water from the managed areas through properly configured water control structures when favorable wind and tidal conditions occurred, typically in

late winter through early summer. It only took one or two successful draw downs for any manager to conclude that marsh plants, especially the highly desirable submerged aquatic species (Chamberlain 1959), responded well to water level reduction and control.

With the potential to affect how much and what kind of marsh plant communities occurred within managed areas, it follows, from ecological theory (Smith, 1980), that managers could influence (indirectly) the collection of animal species associated with managed areas. This had obvious economic implications regarding waterfowl and furbearers. Since that time, managers have and often do elect to enhance economic or recreational interests through marsh management (NOD's permit data base), sometimes with as much vigor as their effort to affect marsh loss rates. Managers since then have come to appreciate even more fully that relationship.

### 4.3.2. An Additional Emphasis Emerges

During the 1970's and 1980's, the magnitude of the marsh erosion problem was quantified and was prominent enough to capture the attention of the Louisiana Department of Natural Resources (DNR) and the NRCS, and the US Department of the Interior - Fish and Wildlife Service (FWS). By the mid-1980's, the DNR and NRCS had begun to encourage water or marsh management planning activities (Spicer, Clark, and deMond, 1986) as a way to stem marsh losses.

Their advocacy during that time represented the vanguard of the evolving perceptions and sophistication of marsh management and reflected the following assumptions: 1) Louisiana's coastal marshes have eroded, still are eroding and will continue to erode at something approaching recent, rapid rates; 2) these losses threaten the ecology, economy and culture of Louisiana; 3) man's past activities have caused some of the marsh erosion problem; thus, 4) man has an obligation to intervene to stem erosion rates, where practicable. Their position was appealing. It was founded upon and embraced the relatively unchallenged and reasonably well demonstrated potentialities of marsh management to successfully affect the population dynamics of animal species traditionally targeted for management by controlling and modifying their habitat conditions. Their expectation was that variations on that successful theme could lead to invigorating vegetation on native, uneroded soils as well as encourage the revegetation of exposable, eroded marsh substrates, thereby combating the combined effects of subsidence and sea level rise by enhancing the growth rate and vigor of marsh plants and stimulating root zone growth rates. Furthermore, their expectation had a recognized

theoretical basis (Linde 1969). Thus, they reasoned that their approach represented nothing more than a new and novel application of an older, proven technology. Their approach has become the conceptual model for modern marsh management.

However, others remained skeptical. The fundamental operative mechanism(s) and the potential wide-scale applicabilities of the emerging concept had yet to be independently and conclusively demonstrated from either previously implemented actions or on-going field applications. Still others were uneasy because of the perceived social and economic implications.

Nonetheless, applications received by NOD to manage marshes escalated during the 1980's (Appendix A). The escalation occurred partly in response to positions taken by DNR and NRCS but also because marsh management was appreciated by land owners and leaseholders to still be an attractive, site-specific solution that comprehensively and in a complimentary manner could address a number of biological concerns (Broussard, Undated) or did address one of several other social, economic, legal or administrative problems linked, directly or indirectly, to the amount or condition of the marsh (Wilkins and Wascom 1989).

Even during the last 10 years, the full potentials and capabilities of marsh management relative to arresting marsh losses and the details that define all the broader consequences have not been resolved. Largely based upon anecdotal evidence and subjective insight, the debate between proponents and opponents continued as they speculated and debated about the scientific, social and economic merits of marsh management as a comprehensive and complimentary approach to addressing most marsh issues.

Publication of Cahoon and Groat's (1990) study of marsh management was one response to that continuing debate. To the surprise of some proponents as well as some opponents of marsh management, that study didn't confirm, expand or diminish the utility of marsh management. Instead it provided partial answers to a limited set of questions about the biological potentialities and shortfalls of marsh management.

The advent of the Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) was also a landmark event. It is a forum to address in greater detail the biological implications, potentialities and effects of marsh management (as one of several other approaches to stemming marsh losses) and design and fund plans that reflect the broader social and economic implications of managing marshes (Steller et al 1993). As a result, a form of managing

marshes, hydrologic restoration, was formally recognized (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993).

## 4.3.3. Why Manage Marshes Into the Future

The ability to reap some of the more traditional social and economic values associated with marsh dependent biological resources has been for years a highly motivating reason to manage marshes. It is likely to remain a highly motivating reason to manage marshes during the next 20 years, and beyond. However, since the early 1980's, other economic, social and legal reasons to manage marshes have emerged. A few have become progressively more influential in management decision making (Wilkins and Wascom, 1989). In fact, landowners and leaseholders that don't attempt to retain as much vegetated landscape as they can on their holdings must contend with administratively created disincentives (Wilkins and Wascom, 1989). Paralleling the emergence of that social and economic perspective of managed marshes was an emerging appreciation of the broader biological values and functions of marshes.

Apparently, the perception and evolution of marsh management began moving more in concert. CWPPRA suggests that marsh management is seemingly perceived ever more frequently by all involved as one of several alternative defensive approaches to addressing coastal erosion in limited situations (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993) and, as Chabreck (1994) noted, inherently address a multitude of concerns. Perhaps that's why most CWPPRA marsh management plans feature measures to control erosion, subordinating other interests. Yet, even some CWPPRA plans feature measures intended to improve habitat conditions for selected animal species if the situation calls for such action.

## 4.3.4. Modern Marsh Management Strategies

Marsh management always has and always will fundamentally deal with affecting water to achieve some greater purpose.

As early marsh managers learned, selectively and differentially controlling several hydrologically-influenced attribute(s) of a marsh is typically required to set in motion a chain of events leading to the desired management outcome. For example, a traditional waterfowl or furbearer manager may have had to start by installing or upgrading a set of water control structures simply to acquire the potential to induce (and sustain) different degrees of change in the salinity (and/or depth of flooding, duration of flooding, etc.) of a targeted marsh. Once the structures

were operational, the manager would proceed to induce a great enough change in some predetermined suite of hydrologically-influenced attributes. If successful, then the manager had to sustain those artificially created abiotic conditions long enough for the anticipated and generally corresponding biotic change of the marsh plant community component(s) to occur. Only after the manager observed the marsh plant community responding according to expectations was it possible to gain some sense of how well the targeted animal species could be expected to respond to that year's management effort. And that expectation would reflect a comparison of the managed areas current condition relative to efforts from previous years and/or what the corresponding waterfowl, furbearer, or alligator population and harvest would have been without management.

Like their predecessors, modern managers of marshes still strive to selectively and differentially control several hydrologically-influenced attribute(s) of a marsh. And, managers still strive to set in motion a chain of events leading to the desired management outcome. However, success is gauged ever more frequently by whether the management effort forestalled the loss of, or how much it was able to slow, stop or reverse the loss of, native marsh soils and plants. The assumption is that the net effect is beneficial on the functions and values of managed marshes that exhibit increased emergent and/or submerged aquatic plant biomass and coverage. A corollary assumption is that marsh-dependent animal species traditionally targeted for management are also unavoidably benefitted, although maybe not quite as much.

The manager's record of how the marsh plant community responds to management efforts provides the primary basis for determining to what degree the functions and values have changed. And that determination would reflect a comparison of the managed area relative to efforts from previous years and/or with surrounding unmanged marshes.

The results of a modern management program, therefore, can be gauged by the collective consequences of efforts to deliberately and in a prescribed manner modify to some degree the role(s) certain attributes of water play on the dynamics of the targeted marsh. The effects as well as the success of the effort could be determined accordingly.

### 4.3.5. The Design of Current and Future Management Efforts

#### 4.3.5.1. Marsh management

##### 4.3.5.1.1. Passive marsh management

The term *passive marsh management* applies to those progressively less frequent situations when attempts to achieve the desired management goal(s), typically water level retention and enhanced growth of pond plants, nearly always relies upon the use of fixed-crest weirs, whether or not in association with levees. There is no intent to completely isolate the targeted marsh from the surrounding system. However, periods of little or no intercommunication between managed and unmanged marshes can occur but typically last only so long as tidal water levels are below the fixed level of the weir crest.

4.3.5.1.2. Active Marsh Management

For those instances when it appears that erosion cannot be otherwise forestalled, changes in marsh condition cannot be affected by other means, or management goals can only be achieved by overriding prevailing and foreseeable hydrologic conditions, the management alternative is referred to as *active marsh management*. In effect, hydrologic conditions in the targeted marsh are intentionally created such that the rhythms and dynamics (and often water chemistry) of the surrounding marsh are significantly muted, and for periods, turned off. These conditions are presumed necessary to achieve the management goal(s). Some would argue that because of how much the hydrology can be muted, this management strategy can be more impact intensive to biological and social functions and values associated with the targeted marsh.

4.3.5.1.3. Hydrologic Restoration

The term *hydrologic restoration* describes a management effort largely intent upon forestalling/preventing erosion or stopping/reversing it very early. Through the use of structures, conditions are established in the targeted marsh area that emulate some historic, often natural, hydrologic condition, thereby presumably reducing the influence of the current day erosional forces to levels when they were of little or no concern. This management option can encompass large areas (e.g., sub-basin or watershed) and does not necessarily entail hydrologically isolating the targeted marsh.

## 4.4. **Geologic, Physical, Meteorological and Chemical Environments of Louisiana's Coastal Marshes**

Louisiana's coastal marshes are the product of the relationship between climate, ocean depth and coastal topography. Like their counterparts throughout the world, Louisiana's coastal marshes acquire their life requisite resources from the atmosphere, soil and/or water. Thus, the

location and extent of Louisiana's coastal marshes as they occur today, as well as the how far they may have extended "seaward" or have retreated landward over time, are conclusive evidence that favorable marsh plant growth conditions are not static in space or time.

Today's Louisiana's coastal marshes are testimony to the influences of global-scale forces that prevailed nearly two million years ago. Ocean depths successively rose and fell as much as 400 to 500 feet in response to alternating periods of warm and cold climates. Continental land surfaces eroded at differing rates. Great and little rivers appeared and disappeared, their loads of sediments being deposited in the relatively lower energy environment that occurred at the then-existing interface between ocean and land. Over time, the nearshore sea floor elevation rose toward the water surface. The most recent cycle of fall and rise began about 80,000 years ago.

Within the last 5,000 years, the mouth of the Mississippi River has relocated several times. Wherever the river's mouth was located, sediments were deposited creating a delta. Each delta was laid down over a period of several hundred years. As the surface elevation of the deposited sediments of an accreting delta rose to meet or break through the water surface, conditions became progressively more conducive to the appearance of marshes. Those marshes were the precursors of today's Louisiana delta marshes.

When more westerly deltas were being created, the riverine influence extended more westerly along Louisiana's coastline. More finer-grained river-origin sediments were translocated westerly, intermingled with larger-grained Gulf-origin sediments, and accumulated in the relatively lower energy, shallower Gulf water depths seaward of the Pleistocene terrace. When more easterly deltas were being formed, riverine influences decreased along Louisiana's more western shoreline. The higher energies of the Gulf became more influential. Previously deposited sediments were remobilized. Finer materials were sorted out and carried away. The remaining larger grained sediment components were redistributed and "windrowed" by the prevailing forces into beach front ridges making the Gulf shoreline. This process occurred several times. The result was the creation of a series of roughly parallel beach front ridges. Those ridges are called cheniers, which is the basis for the name of the Chenier Region.

In accreting areas, substrate elevations rise faster than water levels change and substrates compact or slide down the slope of the continental shelf. Wave and tidal action can redistribute some of the deposited sediments many times

before they are more or less stabilized through compaction/consolidation. When sediment surfaces come under the influence of the daily tidal cycle and climatic events, conditions become conducive to supporting the growth of marsh plants within shallow flooded areas, as well as where substrates are exposable or exposed during part of the tidal cycle. In eroding areas, the soil elevation/water level relationship becomes progressively unfavorable as soil elevations move downward and away from water levels (Day and Templet, 1989).

Never has the mouth of the Mississippi River exactly reoccupied a former position. However, the relocations of the river's mouth all occurred within an approximately 200-mile wide stretch of the Louisiana portion of the Gulf coast. Accordingly, several successively newer deltas overlay portions of earlier deltas. The Atchafalaya and active Mississippi River deltas are the two newest deltas. The Barataria, Terrebonne, Vermilion, and Pontchartrain Basins generally correspond with deltas of increasing age respectively, which is the basis for the name of the Delta Basins.

These deltas are all underlain by the Louisiana portion of the continental shelf as it descended into the Gulf. The shelf descends more steeply under Delta marshes than under Chenier marshes. Whatsmore, depth to the shelf increases as one nears the Gulf shoreline. Additionally, old, buried river valleys that ran from the upland to the Gulf have filled in over the centuries. Kuecher (1995) suggests that subsurface geomorphologic attributes can influence marsh soil elevations.

The global climate has not changed very dramatically over the last several thousand years but we have been and still are in a relatively warm phase. The level of the sea has been rising measurably (about five hundredths of an inch per year) and is expected to continue to do so Penland and Ramsey (1990). How much it will rise and the consequences at a regional, basin or project site scale can't be predicted in absolute terms.

In relative terms, the Terrebonne Parish marshes exhibit the fastest rate (about one-half inch per year) at which the elevation of the marsh soil surface moves downward and away from sea level than elsewhere in the Louisiana coastal marshes (Penland and Ramsey 1990). But for the sediment replenishment provided by the Atchafalaya River, the marshes that surround Vermilion and the Cote Blanche Bays would exhibit the highest rate (Penland and Ramsey 1990). Elevation of marsh surfaces to the east and to the west are also declining relative to sea level but at progressively

slower rates more east or west one goes from the Terrebonne Parish marshes.(Penland and Ramsey 1990).

The sun and moon impart identifiable signatures on the tidal dynamics along Louisiana's coast and in Louisiana's coastal marshes. Those effects are measured in terms of predictably reoccurring approximately monthly cycles and more often in inches of water level change rather than feet.

Nearshore and inshore bathymetry also have effects. The magnitude of water level changes progressively diminishes as distance inland from the Gulf and distance from tidal passes increases. Bathymetric influences have been relatively unaltered over the last several hundred years.

In marshes nearer the Gulf, regular, daily (and in some cases twice daily) tidal changes flush the soil profile (Gosselink 1984; Gosselink, Cordes and Parsons 1979). As distance from the Gulf increases, the tidal effect diminishes, giving way to flooding driven more by the effects of upstream runoff and winds.

In the Delta the differences are dramatic. Delta marshes along the coast are flooded on average for about 12 hours each day whereas flooding duration increases to as much as four to five days in Delta freshwater marshes. However, because of seasonal differences, due to the physico-chemical effects of prevailing wind direction and speed (Barlow 1956), barometric pressure and water temperature, flooding duration in mashes closer to the Gulf can approach 70 to 80 percent of the time in September and October (Gosselink 1984; Gosselink, Cordes and Parsons 1979).

Two examples illustrate the role of climate in Louisiana's coastal marsh dynamics (Gosselink 1984). The passage of winter cold fronts is preceded by increasing winds from the south which can cause water levels to rise several inches. After a front passes, typically accompanied by rain, west and/or north winds "blow" water out of the marsh, with the potential to reduce water levels by a much as two feet. A reduced water level condition may persist for several days because of the prevailing high barometric pressure and winds associated with the prevailing weather system. As atmospheric pressures and winds equilibrate, water levels again return to normal in advance of the next cold front passage. In contrast, from mid-summer (just after the marshes typically reach their growth peak) through fall, a hurricane (extremely high wind, intensive rainfall, very low barometric pressure) over a period of several days can force up to 10 to 15 feet of water into those same marshes.

The duration and timing of precipitation, seasonal and local

differences in temperature patterns, seasonal and daily changes in barometric pressure, wind speed and wind direction are all influential components of the climate that influence Louisiana's coastal wetlands (Gosselink, et. al. 1979). Just like the effect of the sun and moon impart identifiable and separate signatures on tidal dynamics, these climatic components also exert separable, identifiable influences on water levels. For example, monthly average air temperatures exhibit the same yearly pattern throughout coastal Louisiana's marshes but are a degree or so warmer in the more southern coastal marshes and also tend to be warmer in the more western marshes. Rainfall occurs throughout the year in coastal Louisiana marshes. Maximum monthly amounts fall in July as the result of localized thunderstorms. Appreciably lesser amounts fall in October. During winter, rainfall usually accompanies frontal passage. Nonetheless, the average yearly total of nearly 60 inches per year occurs in the more eastern marshes while the western marshes receive about 50 inches per year. Wind speeds are generally lower and from the south in summer. During the winter the prevailing wind direction is more northerly and wind speeds are measurably higher on average.

The distribution of Louisiana's coastal marsh types has been described relative to surface water salinity regimes (Sasser 1979). Average salinity and the range of salinities generally decrease as the distance inland from the Gulf shoreline increases. The plants that comprise the coastal marshes are not equally able to contend with the entire range of salinities that occur throughout coastal Louisiana. Instead, plants with similar salinity tolerances grow in association with one another. The associations are so distinctive four marsh types have been identified and described relative to prevailing salinity regimes. The four types occur in four bands that are aligned roughly parallel with the Gulf shoreline (Chabreck 1972, Chabreck and Linscombe 1982). The most salt tolerant marshes occur at the Gulf of Mexico shoreline. Inland from there, tolerance to both average and maximum salinity decreases.

Regardless of marsh type, salinity, in combination with low or no oxygen soil conditions in the root zone, can, as the result of chemical reactions can affect/immobilize plant nutrients (Pezeshki and DeLaune 1990; Day et al 1989), immobilize plant nutrients, affect plant physiology (Pezeshki, DeLaune 1987; Pezeshki et al 1989) and growth patterns (Pezeshki and DeLaune 1990; Pezeshki, Matthews and DeLaune 1990), and, if conditions persist, can accentuate the build-up of compounds toxic to plant growth (Pezeshki, DeLaune and Pan 1991; Mendelssohn, McKee and Patrick 1981). Prolongation of such conditions can lead to the death of many if not all of the affected marsh plants (Koch and

Mendelssohn 1989).

Marsh soils arose in response to past processes occurring along several different time and spatial scales (Gosselink, Cortes and Parson 1979; Gosselink 1984). Because those processes were not expressed uniformly, different marsh soil types have arisen. Organic and mineral content are two easily measured attributes of soils. The reactive weights of organic components to mineral components of marsh soils has been shown to be an attribute with which the presence or absence of a very common marsh grass can be correlated (Pezeshki, et. al., 1988), illustrating the point that marsh soils can effect marsh plant distributions.

Vegetated marsh soils are more resistive to erosion than the same soils in an unvegetated condition. That is evidence that marsh vegetation can affect attributes of marsh soils.

Reciprocal relationships between marsh soils, marsh plants and soil composition and accretion (Nyman et al (1993f), and marsh dependent animals have also been demonstrated. For example, burrowing animals create avenues for water and oxygen to more quickly exchange within the root zone (Day et al 1989; Gosselink 1984). Casting made by burrowing animals become large grained sediment depositions. Marsh plants, and dried algae mats, are irregularities on the marsh surface that slow water movements, enhancing sediment settling. Nutria, however, can denude areas (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor Grace 1992) exposing the fragile marsh surface to erosive forces or undermine an area with their borrows so thoroughly that the marsh surface caves in and washes away (Foote and Johnson 1992, 1994; Linscombe 1993; Taylor Grace 1992).

Thus, the marshes that comprise Louisiana's coastal zone may appear to the eye to be very much alike. Looks can be deceiving. In fact, they do not have the same geologic history or underpinning, are differentially influenced by several climatic, salinity and chemical gradients, occur in several different soil types and can affect and be affect by dependent organisms. Whatsmore, Louisiana's coastal marshes are no longer accreting at a rate that can keep pace with or outpace nature's destructive forces (Chabreck 1972, Gagliano et al 1981; Dunbar, Britsch and Kemp 1990, 1992; Britsch and Kemp 1990).

Managers must understand which factor(s), that comprise the suite of physical, chemical and biologic factors affecting coastal marshes, have been influential, are currently influential and may in the future become influential over the marsh targeted for management. Ideally, the manager

should be aware of those same concerns for the larger system of which the targeted marsh is a part. With that collective understanding, the manager can determine what is preventing the marsh from exhibiting the desired characteristics. With that insight, the manager can determine which influential factors need to be controlled, to what degree, and determine how that can be done. The degree of control that can be exerted over those factors will determine the degree of success the manager can expect to achieve.

Managers cannot affect when, where or for how long rainfall occurs, how great barometric pressure changes may be or for how long after the front passes water levels may remain low, the type of soil they have to work with, how fast sea level rises, or how quickly the sediments that comprise the marsh soil in the area compact or slide down the face of the continental shelf (subside). But, managers have learned from experience, and have conclusively documented, what can be done to retain fresh water longer, to control where and when water flows, to maintain fairly constant water levels in response to seasonal climatic events and trends, as well as the structures (and their operation) needed to slow, stop or reverse shoreline erosion or to directly influence plant growth and trigger and control the seasonal movements of some marsh dependent animals. All of that insight has been acquired and is used by managers to compliment and maximize their management efforts.

## 4.5. **Louisiana's Coastal Marsh Types and Their Associated/Dependent Biological Resources**

The hydrologic basins referred to in this section as those described by Chabreck (1972, see also Appendix H). The Delta Region Basin are the Pontchartrain Basin (Basin 1), the Breton Basin (Basin 2), the Barataria Basin (Basin 4), the Terrebonne Basin (Basin 5), a the Teche-Vermilion Basin (Basin 7). The Chenier Region Basins are the Mermentau Basin (Basin 8) and the Calcasieu-Sabine Basin (Basin 9).

Salinity regime, soil composition, depth and frequency of flooding, plant species composition and associated/dependent species are all used to describe each of the four marsh types that comprise Louisiana's coastal marshes. The four marsh types occur in both the Delta and Chenier regions but not in all basins.

Penfound and Hathaway (1938) described the four coastal marsh associations - fresh, intermediate, brackish, and saline. Chabreck (1972) resurveyed those marsh types and collected information on soil types and composition, salinities and selected nutrients thereby presenting an expanded profile of Louisiana's coastal marshes. Brupbacher

et al (1973) was able to correlate measured differences in soil chemistry with increasing organic matter content, which also correlated with marsh type. Sasser (1977) examined the relationship between several plant species and the depth and duration of tidal flooding in delta marshes. Collectively, those four works represent a time-honored source of valuable information that has been used to classify marsh types. Several other investigators have subsequently investigated the salinity relationships (Gosselink 1984). The reader is urged to refer to those publications if more insight is required.

### 4.5.1. Fresh Marsh

#### 4.5.1.1. Plant Species

Throughout coastal Louisiana, rushes, maidencane and bulltongue (Eleocharis spp., Panicum hemitomon and/or Sagittaria falcata, respectively) are two to three times more prevalent than any of the nearly 90 other fresh marsh plant species (Chabreck 1972). Alligatorweed (Alternanthera philoxeroides) and salt meadow grass (Spartina patens) were prevalent co-associates (Chabreck 1972). Forty-nine species were unique to the fresh marsh type, accounting for less than 10 % of the marsh type species composition (Chabreck 1972). Twenty-one species occurred as components of the intermediate and brackish marsh types but only four species (spike grass, Distichlis spicata; black rush, Juncus roemerianus; loosestrife, Lythrum lineare; and salt grass) occurred in all four marsh types (Chabreck 1972). Loosestrife was a minor component in all four marsh types (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

#### 4.5.1.2. Soil Types and Chemistries

Brupbacher et. al. (1973) reported that fresh marsh occurred on two types of mineral (less than 16 % organic matter) soils and two types of organic soils (greater than 16 % organic matter). Organic matter content ranged from about two percent (mineral - clay) to 89 % (organic -mucks and

clays) (Brupbacher et. al., 1973). From his chemical assays, it appears that the more organic mucks and peats are discernibly different from the other organic soil as well as the two mineral soils.

Chabreck (1972) reported the same trend except in the Calcasieu-Sabine basin where the average and range of organic material suggest the existence of between as well as within basin differences. Small sample sizes preclude more definitive statements.

Assays of chemical species of fresh marsh soils revealed repeating trends with much overlap but marked differences between the two most disparate soil types (mineral clays and the organic mucks and peats clays) (Brupbacher et. al., 1973). Chabreck (1972) recorded similar trends of the same magnitudes.

4.5.1.3. Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports.

4.5.1.4. Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to in excess of six ppt. Basin salinity averages, their variation and their range each spanned an order of magnitude. Differences between basins were suggested more so than any suggestion of regional differences.

The salinity regime in the Pontchartrain basin seemed to exhibit generally higher levels both on average and as peaks than any of the other Delta basins.

No single comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972). What does exist is salinity tolerance profiles for many marsh plants.

4.5.2. Intermediate Marsh

4.5.2.1. Plant Species

Salt meadow grass was an order of magnitude more prevalent than any other plant species (Chabreck 1972). Bull tongue,

water hissop (Bacopa monnieri), reed grass (Phragmites communis) and jointgrass (Paspalum vaginatum) were about twice as prevalent as any of the 49 other plant species that comprise this marsh type (Chabreck 1972). Three species occurred as a component of only the intermediate marsh type (Chabreck 1972). Forty-four species occurred in fresh marshes (Chabreck 1972). Thirty-one species occurred as components of the brackish marsh type, of which only eight occurred as components of the saline marsh type (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

4.5.2.2. Soil Types and Chemistries

Brupbacher et. al. (1973) did not report results for this marsh type.

Chabreck (1972) encountered intermediate marsh in all but the Atchafalya basin. Intermediate marsh occurred on both mineral and organic soils. Organic matter content ranged from less than one percent to nearly 83 %. Only in the Barataria basin did this marsh type tend to occur as much or more on mineral soils than on organic soils. The averages and ranges of organic matter content suggest the existence of between as well as within basin differences. Small sample sizes preclude more definitive statements.

Chabreck's (1972) assays of chemical species from intermediate marshes are not definitive relative to the potential for within basin differences because of extremely small sample sizes. Suggestions of between basin differences may also be artifacts of small sample sizes.

4.5.2.3. Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports.

4.5.2.4. Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 10 ppt. Basin salinity averages were of the same order of magnitude. Only the recorded ranges differed by an order of magnitude. Differences between basins were suggested more so than the possible existence of regional differences but those trends may be an artifact of small sample sizes. The salinity regime in the Barataria basin seemed to exhibit generally higher levels both on average and as peaks than any of the other Delta basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972).

4.5.3. Brackish Marsh

4.5.3.1. Plant Species

Salt meadow grass was four times more prevalent than spike grass but both were an order of magnitude more prevalent than any of the other 38 species that comprise this marsh type (Chabreck 1972). Of those 38 species, four species {oyster grass (S. alterniflora), widgeongrass (Ruppia maritima), three square sedge (Scirpus onleyi), and black rush} are the most prevalent (Chabreck 1972). Five species occurred as a component of only the brackish marsh type (Chabreck 1972). Only three species occurred as components of only the brackish and saline marsh types and all three occur infrequently (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

4.5.3.2. Soil Types and Chemistries

Brupbacher et. al. (1973) reported that brackish marsh occurred on both mineral soils and both organic soils. Organic matter content ranged from about two percent (mineral - clay) to 85 % (organic -mucks and clays)

(Brupbacher et. al., 1973). From his chemical assays, it appears that his soils encompass consistent chemical gradients, the end points of which are decidedly different.

Chabreck (1972) encountered brackish marsh in all but the Atchafalya basin. Brackish marsh occurred on both mineral and organic soils. Organic matter content ranged from less than two percent to nearly 86 %. The data suggest that the organic matter content of Chenier brackish marshes were more similar to each other and measurable lower than Delta brackish marshes.

Chabreck's (1972) assays of chemical species from brackish marshes tend to reinforce and expand the suggestion of difference between brackish marshes that occur in the various basins, even with the same region.

#### 4.5.3.3. Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz 1995, Sasser 1995). If that information does exist, it is probably in the form of unpublished studies or reports.

#### 4.5.3.4. Salinity

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 29 ppt. Basin salinity averages spanned an order of magnitude. The higher the average salinity the less variations in salinity there appeared to be. The Vermilion-Teche, Mermentau and Calcasieu-Sabine basins evidenced lower average salinities with wider salinity variations than did the Pontchartrain and Breton basins. Those trends are suggestive of a salinity gradient that increases from west to east across the coastal zone but with a tendency for greater swings in salinity in the western basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972).

### 4.5.4. Saline Marsh

#### 4.5.4.1. Plant Species

Oyster grass was about five times more prevalent than the two next most abundant species (salt grass and black rush)

(Chabreck 1972). Each of those three species was an order of magnitude more abundant than any of the 14 other plant species that comprise this marsh type (Chabreck 1972).

Between basin differences were also apparent (Chabreck, 1972). Similar but not identical numbers of plant species comprise each marsh type across all basins. And, one, two or even three species tend to occur in the same marsh type across all basins. However, the proportions of even the commonly occurring species differed by multiples or an order of magnitude between basins.

Why such differences occur and the biological significance of such differences remain to be fully explained. Possibly influential factors are profiled below.

4.5.4.2. Soil Types and Chemistries

Brupbacher et. al. (1973) reported that the saline marsh type occurred on mineral and both organic soils. Organic matter content ranged from about four percent (mineral - clay) to 77 % (organic - mucks and clays) (Brupbacher et. al., 1973). From his chemical assays, it appears that his soils encompass consistent chemical gradients, the end points of which are decidedly different.

Chabreck (1972) encountered saline marsh in all but the emerging birds-foot delta and the Atchafalya basin. Saline marsh occurred on both mineral and organic soils. Organic matter content ranged from less than one-half percent to more than 66 %. The very limited data from the Chenier basins and the Teche-Vermilion must be treated with great caution because of their extremely small sample sizes. They offer no insight into potential within basin differences. However, as a group compared to the remaining eastern Delta basins, measurable differences have been recorded suggesting there may be real differences in the composition of the soils.

Chabreck's (1972) assays of chemical species from saline marshes tend to reinforce and expand the suggestion of difference between saline marshes that occur in the various basins.

4.5.4.3. Flooding Depths and Durations

No comprehensive compilation of species specific responses to increasing levels and duration to flooding exist (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports.

4.5.4.4. Salinities

Chabreck (1972) assayed free soil water for salinities. Recorded levels ranged from less than one part per thousand (ppt) to nearly 52 ppt. Differences between Delta basins were suggested more so than the possible existence of regional differences but those trends may be artifact of small sample sizes.

The salinities recorded in the Breton basin were the highest on average and exhibited peaks nearly double those in any other basin.

Basin salinity averages spanned an order of magnitude. The data suggest that the higher the average salinity the less variation in salinity occurred. The Vermilion-Teche, Mermentau and Calcasieu-Sabine basins evidenced lower average salinities with wider salinity variations than did the Pontchartrain and Breton basins. Those trends are suggestive of a salinity gradient that increases from west to east across the costal zone but with a tendency for greater swings in salinity in the western basins.

No comprehensive compilation of species specific responses to increasing salinity levels exists (Montz, 1995; Sasser, 1995). If that information does exist, it is probably in the form of unpublished studies or reports. Such information would be insightful in interpreting the differences reported by Chabreck (1972).

4.5.5. Synthesis

A Louisiana fresh, intermediate, brackish or saline marsh in one part of the coastal zone can look and be structurally quite dissimilar from the same "type" of marsh in another part of the coastal zone. The fresh "floating" marshes in Terrebonne Parish and the fresh "hard bottom" marshes in Cameron Parish are excellent examples. Thus, looking at one or two attributes of a marsh type may lead one to conclude that a type can occur over a wide range of environmental conditions.

To an extent that is true. However, each type can also be thought of as a collection of graded biological responses to patterns of interactions between several influential soil, hydrologic, chemical and biotic attributes. Therefore, each manifestation of a Louisiana coastal marsh type could be a fairly localized, site specific, specialized response to a unique set of interacting factors. As examples, Chabreck (1970) noted differences between soils, physico-chemical parameters and plant communities on active versus inactive delta formations that he reemphasized in 1994 (Chabreck 1994). Also, Nyman, Delaune and Patrick (1990) reported differences in wetland soil formation processes on active

and inactive delta sites relative to mineral and organic matter relationships. Thus, management plans that encompass one or more marsh types, and are formulated from generalized experiences (that span rather than focus on very localized scales), could produce vegetative as well as dependent animal responses below expectations.

## 4.6. **Marsh (Land) Loss**

Louisiana's coastal marshes are the result of an ever present, dynamic interaction between factors that result in marsh creation opposed by factors that lead to marsh losses. Some factors are expressed on geologic time frames (e.g., decades, centuries) or regional scales (e.g., physiographic regions). In contrast, others are expressed on short time frames (e.g., days, weeks, months) or relatively small geographic scales (e.g., tens, hundreds, thousands of acres). Therefore, the effects of shifts in some factors may be detected more readily than others.

Seldom was or is there truly a period of prolonged absolute balance anywhere or at anytime in Louisiana's coastal marshes. Since about the early 1800's, man has been accidentally as well as intentionally influential in modifying some of those factors. Channelizing and leveeing the Mississippi and Atchafalaya Rivers, and the excavation of waterways for navigation are examples of man's actions that have impacted several influential factors.

The general effect of man's actions in Louisiana's coastal zone has been to accentuate the factors that result in ambient marsh losses (Gagliano et al 1981). The effect has been to stress or exceed the ability of marsh plants to contend with the induced differences. Thus, especially over the last 40 years, marshes have eroded at various rates and the probability of marshes continuing to erode at an accelerated rate is seemingly inevitable (Gagliano et al 1981) if corrective actions are not taken. Gagliano's projection has not been substantiated by subsequent studies (Britsch and Kemp 1990; Dunbar, Britsch and Kemp 1990, 1992).

### 4.6.1. Marsh Erosion and Marsh Deterioration

The generally accepted perception of erosion is used in this PHMEIS. Erosion is a process resulting in the appearance of open water where once there was a marsh soil surface covered with vegetation. As a marsh erodes, different vegetative assemblages, unlike those that originally existed, may appear from time to time prior to the total loss of the marsh soil and the demise of the emergent marsh vegetation.

Some of the vegetative assemblages that may appear and disappear prior to the actual loss of the marsh soil have been [popularly referred to as eroded or deteriorated marshes. An even narrower use of the term marsh erosion refers to the situation where marsh plants, not particularly attractive to wildlife, had begun to grow and flourish on substrates that had filled-in an area that was once open water (Joanen, Pers. Comm.).

4.6.2. Forms of Erosion

There are two generally recognized forms of marsh erosion. One is shoreline erosion. The breakup of internal marsh is another kind of marsh erosion.

4.6.2.1. Shoreline Erosion

Shoreline erosion is caused by the mechanical action of waves, exposed marsh soils, and the vegetation growing on it, along ponds or other open water situations, are unable to withstand the impinging energy. The result is the mobilization of soil particles, sloughing of banklines, and transport of marsh clods.

4.6.2.2. Internal Marsh Erosion

What follows is an abbreviated description of internal marsh erosion. It consists of a generally accepted sequence of events and stressors. It is largely adopted from Cahoon and Groat (1990). It is based on years of historical observations and is a blend between and encompasses presumed causative factors and fairly predictable occurrences. Gagliano and Wicker's (1989) site-specific narrative of wetland erosion is an example of where many of the elements of this scenario are apparently operative. Not all stages must nor are expected to occur.

> Emergent marsh grasses growing on native or exposed mineral soils can become stressed by salinity or soil waterlogging. The potential for soils with progressively higher organic content to become mobilized as water velocities increase can become an additional stress to rooted plants. When stressed sufficiently, the vigor of the marsh grasses diminishes. The grasses become progressively less able to maintain themselves, eventually dying. Once dead, their interwoven root systems decompose and can no longer bind the soil. If other grass species were unable to become established on the marsh soils in the meantime, the elevation of the surface of the marsh soils would tend to decrease as successive increments of soil became mobilized and transported away. Water

filled depressions could then be expected to appear where marsh grasses had once grown on native soils, and the depth of the developing open water increases until erosion exposes a soil horizon that is resistive to further erosion.

Depending upon the severity or kind of stress, this process could be fully expressed within a single growing season or occur over several growing seasons.

### 4.6.3. New Marsh Erosion Insights

Recent field studies by Nyman et al (1993a, 1994) suggest that the natural process of water draining from the marsh due to winter storm tides may mobilize soils material from below the root zone. This is a very subtle phenomenon and was noted only by coincidence.

Less a new scenario, and more a developing appreciation, the biological effects of nutria on marsh production, dynamics and vigor is gaining notoriety (Llewellyn and Shaffer 1993; Linscombe, 1993). Nutria grazing can create conditions that cause a marsh to erode that mimic the symptoms of erosion for completely different reasons (Foote and Johnson 1994).

Apparently, erosion of an otherwise healthy looking marsh can occur for reasons wholly unrelated to normal tidal action, prior management activities, or chemical (i.e., salinity) stress or anything else encompassed within the classic scenario. How generally applicable some of these other scenarios are throughout the Louisiana coastal zone (Nyman et al 1993d), or if there are still others to be discovered, has yet to be determined. What is apparent is that failure to appreciate their existence could lead an observer to an improper conclusion about what was causing the erosion (, or an improper conclusion about the effectiveness of any contemplated or installed management effort (Nyman, Chabreck and Kinler 1993).

Thus, the reasons a marsh converts to open water (or does or does not respond to management according to expectations) may be in response to a few or a complex of factors, many, if not all, may be unique to the marsh in question.

### 4.6.4. Historic Marsh Loss Rates/Deterioration

The terms marsh loss and marsh deterioration are often used interchangeably to describe shifts in marsh plant species assemblages to more salt tolerant marsh types that are less attractive to some marsh-dependant species or to describe erosion - the conversion of a marsh type to open water. However, some Louisiana coastal marshes have changed from

one type to another and back again for reasons totally unrelated to erosion. Therefore, the term marsh deterioration probably should be used carefully and limited to describing a marsh undergoing erosion.

4.6.4.1. Delta Basins

4.6.4.1.1. Basin 1 - Pontchartrain

On an annualized basis since 1932, about 10 % (90,000+ acres) of Basin 1's 1932 land area has converted to open water. After doubling during the 1958-1974 time period, the 1983-1990 annualized percentage and acreage loss rates are approaching the ambient rates observed during the 1932-1958 time frame, or slightly less than about 2.0 square miles per year. Within the basin, current losses are generally greater in the portion of the basin south and east of the eastern rim of Lake Pontchartrain.

4.6.4.1.2. Basin 2 - Breton

On an annualized basis, about 16 % (37,000+ acres) of Basin 2's 1932 land area has converted to open water since 1932. The annualized loss rate as a percentage and as acres lost nearly tripled by about 1960 and has again accelerated since the mid-1970's, and equates to current loss rate of slightly less than 1.5 square miles per year. Within the basin, current losses have generally been greater in the central and southeastern two-thirds of the basin. Shoreline erosion, altered hydrology and subsidence have been identified as contributing to the historic and current losses. The bulk of the targeted marsh losses in this basin occurred predominantly during the 1958-1974 time frame.

4.6.4.1.3. Basin 4 - Barataria

On an annualized basis since 1932, about 16 % (190,000+ acres) of Basin 4's 1932 land area has converted to open water. After tripling during the 1958-1974 time period, the 1983-1990 annualized percentage and acreage loss rates have increased slightly once again. Within the basin, loss rates span an order of magnitude but generally occur evermore rapidly in the central and southeastern two-thirds of the basin. The annualized loss rate of 7.37 sq. mi. per year for the 1983-1990 time frame is the highest, most recently documented loss rate in coastal Louisiana.

4.6.4.1.4. Basin 5 - Terrebonne

On an annualized basis since 1932, about 20 % (200,000+ acres) of Basin 5's 1932 land mass has converted to open water. After exhibiting a five-fold increase during the

1958-1974 time period, the 1974-1983 annualized percentage and acreage loss rates began a slight decline that is still apparent in the 1984-1990 time frame. However, the most recent loss rate is still nearly four times the land loss rate recorded during the 1932-1956 time frame. Within the basin, loss rates span an order of magnitude but the most rapid loss rates occur in the east central and southeastern one-third of the basin. Elsewhere, loss rates are fairly uniform with the exception of some localized exceptions to the general pattern.

4.6.4.1.5. Basin 6 - Atchafalaya

On an annualized basis since 1932, about 9 % (7,800+ acres) of Basin 6's 1932 land mass has converted to open water. After exhibiting a fractional increase during the 1958-1974 time period, the 1974-1990 annualized percentage and acreage loss rates have declined to about half of what they were during the 1932-1958 time frame. These rates are the lowest recorded loss rates throughout coastal Louisiana for the period of record. Shoreline erosion and direct man-made losses account for nearly all the recorded losses.

4.6.4.6. Basin 7 - Vermilion-Teche

On an annualized basis since 1932, about 9 % (50,000+ acres) of Basin 7's 1932 land area has converted to open water. After more than doubling during the 1958-1974 time period, the annualized loss rate has declined and today is slightly less than double the rate for the 1932-1951 period. Within the basin, loss rates can nearly be an order of magnitude different depending upon location. Some of the highest loss rates are correlated with areas of shoreline erosion.

4.6.4.1.7. Delta Basin Summary

Collectively, losses from Delta Basins 1, 2, 4, 5, and 7 amount to about 367,000+/- acres since 1932. Expressed as percentages of each basin area, losses range from nine to 20 percent. Basin 1 and 7 (10 and 9 %, respectively) exhibited half the historic loss recorded in Basin 5 (20 %). Percentage losses in Basin 2 and 4 were identical (16 %).

Erosion of the Gulf shoreline, wetlands that form the rims of large open water bodies, and exposed headlands have been a persistent problem throughout the period of record in all Delta basins. Some localized differences have been noted. Generally, shorelines exposed to long fetches of prevailing winds tend to evidence greater amounts of erosion. Visual inspection of NOD's early draft, color-coded maps of land loss in coastal Louisiana clearly revealed that much of the recorded internal marsh losses occurred in clusters, most

often focused around manmade waterways or manmade surface landscape features (especially so in Basins 4 and 5). Additionally, most of the historic losses associated with clusters around petroleum extraction canal systems occurred within the 10-to-20 year period after the canal system was excavated. Subsequent losses in those same canal system clusters since the 1980's have been proportionately very little.

4.6.4.2. Chenier Plain Basins

4.6.4.2.1. Basin 8 - Mermentau

On an annualized basis since 1932, about 19 % (115,000+ acres) of Basin 8's 1932 land mass has converted to open water. After exhibiting a three-fold increase during the 1958-1974 time period, the 1974-1983 annualized percentage and acreage loss rates changed little. The loss rate from 1984-1990 was lower but is nearly double the rate from 1932-1954. Within the basin, the most recent loss rates span an order of magnitude but the most rapid loss rates occur along the Gulf shoreline and inland along lake rims adjacent to marshes. Localized exceptions to this general pattern do exist.

4.6.4.2.2. Basin 9 - Calcasieu-Sabine

NOD's land loss data set do not include the western-most fifth of this basin. That portion of the basin is administrated by the Galveston District, Corps of Engineers. Thus, the following discussion is correspondingly limited.

On an annualized basis since 1932, about 32 % (117,000+ acres) of Basin 9's 1932 land mass has converted to open water. After exhibiting a nearly 30-fold increase during the 1958-1974 time period, the 1974-1983 annualized percentage and acreage loss rates began a dramatic decline that by the 1984-1990 time frame was still greater than but very near the loss rate from 1932-1955. Within the basin, local loss rates differ but are within the same order of magnitude. Loss rates in the extreme southwestern and southeastern corners of the basin are particularly low.

4.6.4.2.3. Chenier Plain Basins Summary

Collectively, losses from the two Chenier Basins, Basins 8 (Mermentau) and 9 (Calcasieu-Sabine) amount to about 232,000+/- acres since 1932. Expressed as percentages of each basin area, losses are 19 % to 32 %, respectively.

Erosion of the Gulf shoreline in both basins and wetlands that form the rims of large open water bodies, especially in

basin 8, have been persistent problems throughout the period of record. However, visual inspection of NOD's early draft, color-coded maps of land loss in coastal Louisiana clearly revealed that internal marsh losses have been extensive for the period of record in both basins, especially during the 1932-1974 time frames.

In both basins, extensive losses have occurred in proximity to surface features created by man. In the Mermentau basin, losses during the 1932 to 1974 time frames visually appear to exhibit two larger-scale patterns: 1) clustered; and 2) more regularly occurring. Clustered losses were decidedly more visually apparent in and about the several petroleum extraction canal systems north of and easterly from the Grand Chenier ridge. More regularly occurring losses were visually prominent in the marshes between the Grand Chenier ridge and the Gulf of Mexico. Losses that have occurred more recently (1974-1990) are either in the shape of rectangles, especially on the very eastern end of the Grand Chenier ridge or within the area circumscribed by other man made surface landscape features (e.g., northerly from Lake Misere and northwesterly from the northwest shore line of White Lake).

In the Calcasieu-Sabine Basin, marsh losses east of Calcasieu Lake have been most extensive within the area bounded by the GIWW on the north, LA Highway 27 on the east, the Back Ridge chenier system along the south and to the west by the eastern lake rim of Calcasieu Lake. The vast majority of the marsh losses in this area occurred during the 1932-1974 time frame. Areas of marsh loss west of Calcasieu Lake, especially in the eastern half of the vast marsh area between Sabine and Calcasieu Lakes, are notable for their geometric patterns of repeated right angles and long straight margins. Those loss areas coincide remarkably well with formerly impounded and managed areas.

#### 4.6.4.3. Louisiana Coastal Zone Summary

Losses on a percentage basis vary considerably. Basins within the same region exhibit obvious differences. The reason for the losses differ between basins, sometimes more so than do the reasons between regions. These trends suggest that site specific reasons for land (marsh) loss can be determined for many but not all locations and that land loss rates in general have slowed over the last 10 to 15 years. Land (marsh) losses are expected to continue.

### 4.7. **An Overview of the Written Record**

Several hundred publications refer to Louisiana's coastal marshes in some regard. Another group refer to coastal

marshes elsewhere. Many publications from both groups have already been cited in this PHMEIS. There probably are publications that could have been included in the literature base created for this PHMEIS but were not. The location and availability of any additional pertinent publications could be incorporated into review comments.

What follows is an overview of the literature base compiled for this draft document. This overview is not intended to be all-inclusive. However, it is intended to identify information sources and summarizes much of the literature that is available and often referenced.

Hands-on insights of managers should not be underestimated. Over the years managers of individual marshes have acquired insights that probably might surpass the insights even skilled scientific observers probably could acquire from conducting multi-year studies. Unfortunately, insights acquired by managers from years of working with individual marshes are not always reflected well if at all in the documented record.

Predicting how Louisiana's coastal marshes will respond to a given activity is not a precise, unimpassioned, purely objective, quantitative effort. It can be only as rigorous and accurate as the documented record and the collective ability and wisdom of professionals to objectively speculate about what the response(s) reasonably could be for the lesser known components.

The response of some components of Louisiana's coastal marshes to management have received far less attention than others (Day et al 1989). Of the components that have received attention and been documented, some have been studied in more breadth, detail and with more rigor than others.

The quantitative relationships between the factors that influence the structure and chemistry of marsh soils, and the life histories and life requisites of some common plant and typically the economically more important crustaceans, finfish, birds (especially waterfowl) and mammals have been fairly well documented. The factors that influence the rates and interactions of marsh processes and the roles of the participating organisms have been conceptualized.

As can be seen from an inspection of the Literature Cited and Other References section of this PHMEIS, since about the mid-1980s, study efforts have become progressively more research intensive, tending to focus on examining the biologic dynamics of Louisiana's coastal marshes and specific groups of dependent plants and animals. Those

initiatives have also tended to adopt a quantitative, experimental approach to documenting critical processes {e.g., microfaunal roles in marsh loss (Day, 1995), examining components of marsh sediment budgets (Reed 1989 a, b; Nyman, Delaune and Patrick 1990; Reed and McKee 1991; Reed 1991)}. The change appears to have arisen about the same time as the popularity of marsh management began to rise, and apparently continues to interest researchers on broader scales (Callaway, Delaune and Patrick 1992).

Brupbacher et.al. (1973) examined and reported on the chemical properties of the soils of Louisiana's coastal marshes. Chabreck (1972) gave us an authoritative "snap-shot" profile of the vegetation, soil and water characteristics of Louisiana's coastal marshes. Sasser (1977) reported on the correlation between tidal flooding and the distribution of Louisiana's marsh plants in Delta marshes. A text book treatment of general coastal sedimentary environments, with reference to Louisiana, is presented in Davis (1978).

Gagliano et. al. (1981) presented what has become an often referenced estimate of historic land loss rates in Louisiana's deltaic marshes. Those estimates have been updated and extended to more recent times by Britsch and Kemp (1990) for the Deltaic region and Dunbar, Britsch and Kemp (1990) for the Chenier region and by Dunbar, Britsch and Kemp (1992) for the Louisiana Coastal Plain.

Predicting future land loss locations and rates has been an area of recent interest. It has been a source of much interest to the CWPPRA initiative (Barras, Johnson and Johnson 1993). Better ways to predict and measure the response of targeted marshes to management has also been a topic of emerging interest (Boumans, Day and Kemp 1993b). Appendix H accomplishes that task for this PHMEIS

The bacteria, fungi, algae, phytoplankton, zooplankton, and protozoans associated with Louisiana's coastal marshes are components of Louisiana's coastal ecosystems that have been little studied. They are absolutely essential biological intermediaries in the processing and repackaging of nutrients and organic matter for use by other marsh/estuarine organisms (Day et. al. 1989, DeLaune 1995; Myers 1995). Their roles are characterized by measuring the processes they influence and, in turn, what influences them. There is no definitive accounting of their community structures or dynamics. However, salinity, average grain size, percent sand, silt and clay, organic matter content of the sediments influence the distribution and abundance of species that live in or on marsh soils but remain one of the most understudied components of marshes (Conner and Day

1987; Gaston and Nasci 1988). Textbook treatments (e.g., Day et. al., 1989; Mitsch and Gosselink, 1993) with discussions of and examples from Louisiana, supplemented with studies from South Carolina studies of managed coastal marshes (Zingmark 1986, Coull 1986, Wenner 1986), are illustrative of the universality of the responses and relationships. Their response to management is also sparsely reported (Christian, Bancroft and Wiebe 1978; Marshall and McKellar 1986; Taniguchi 1986; Zingmark 1986), but appears that this marsh community component exhibits a compensatory relationship between species in managed and unmanaged areas.

The Louisiana Department of Wildlife and Fisheries (La WL&F) was instrumental in collecting, compiling, interpreting and publishing the bulk of the basic biological life history profiles for oysters, crabs and the several species of shrimp and fish that are commercially important to Louisiana. Over the years, those profiles have been updated as new information became available. The profiles address the factors that control the distribution and abundance of the various life stages. As such, they have proven to be accurate, and therefore, a useful tool used by La WL&F to manage the harvest of those species and by fishermen to affect and improve upon the growth and harvest of those species.

Life history information about many of the other marine/estuarine invertebrate and vertebrate species that permanently or seasonally occur in Louisiana waters and marshes are generally not as thoroughly well developed. Usually, the factors that control their distribution and abundance are characterized in more general terms, with a few better studied species serving as models.

Until about the early 1980's, investigators working throughout coastal Louisiana apparently were intent upon reporting differences they encountered between areas managed with structures and unmanaged areas but with a focus on the management implication (Chabreck 1960; Chabreck and Hoffpauer 1962; Chabreck 1967: Chabreck, Hoar and Larrick 1979; Carney and Chabreck 1977). More recently, investigators and managers began characterizing differences by reviewing previously collected data sets and publishing their interpretations (Chabreck and Nyman 1989; Turner, Day and Gosselink 1989). Searches for differences in the salinity, water levels and/or water temperatures between managed and unmanaged areas in some cases reported finding differences (e.g., Meeder 1989, Roberts and Sauvage 1988) while Rogers (1989) reported finding few differences. Apparently the kinds of structure used for management play a role in any differences that may develop.

For about the last decade, one focus of research efforts involving fishery resources in Louisiana marshes has been on determining the effects of some kind of water control structures on fisheries and the factors that influence them. That interest emerged in response to academic curiosity about the system-wide effects of using certain management practices and structures as well as a desire to know the effects on commercially and recreationally important fishery species.

Herke (1967, 1971, 1979) began compiling evidence that management structures could and did influence the fisheries resources of marshes. Changes arose within a year because several fishery species, including several commercially important species, encountered reduced opportunities to enter and leave the managed area in response to environmental cues such as frontal passage, and water temperature and salinity changes (Herke, Wengert and LaGory 1987). Other water control structure designs evidenced less dramatic responses but still induced measurable differences (Rogers 1989; Rogers, Herke and Knudsen 1987, 1992). The water control structures were concluded to be a physical as well as a behavioral impedance to some species.

Studies on some (Rogers,Herke, Knudsen 1992) but not all the kinds and combinations of structures have yet to be performed. However, based upon Louisiana studies, long-term data collected from several other managed Louisiana chenier marshes (Konikoff and Hoese 1989, Hoese and Konikoff 1990), as well as studies of managed South Carolina (Olmi 1986, Wenner 1986, Wenner et. al. 1986) and a New England salt marsh (Sinicrope et al 1990), structures used for management must be presumed to differentially affect the movements of a wide variety of commercial and noncommercial fishery species between some kinds of managed and unmanged marshes.

Life history details about individual reptilian and amphibian species in Louisiana's coastal marshes are generally well known in broad terms. Additionally, much of the basic information about their general habitat, food requirements, behavior, distribution and abundance is also presented in the popularly published field guides. As salinity increases the distribution and abundance of these species decreases rapidly. A comparatively few reptile and amphibian species are adapted to living in the brackish and saline coastal marsh types. However, detailed insight into how individuals or these animals groups in general respond to efforts to manage Louisiana's coastal marshes is lacking. However, based upon their physiological tolerances to salinity, most species are limited to fresh and intermediate marshes with only a few able to inhabit saltier marshes if/when there are areas that provide relief/escape for the

saltier water, cover and nesting/resting areas. Where management results in reducing salinities to tolerable levels and refugia are present, this group of species is likely to be an indirect beneficiary of management.

Considerably more research, and therefore detailed information, has been collected about the American alligator (Gosselink 1984) Historically they were and currently they are again economically important. Additionally, they received attention because for several years they were a Federally protected species. The Rockefeller Refuge, a facility that is part of the Louisiana refuge system and located in the Chenier region of the state, was where much of the research was done that led to this species's recovery and produced the insight that allows a yearly, statewide harvest of this species as part of the management program. As management efforts often compliment the life requisites of this species but the alligator is seldom the singular target of management , it is often an indirect beneficiary of management.

The standard reference for bird distribution in Louisiana is the somewhat dated Louisiana Birds (Lowery 1974). A revised version is in preparation by other authors. A useful reference for basic data on all coastal species is The Birder's Handbook (Erlich et al., 1988). Brief summaries of basic breeding data, nest site and description, diet, conservation, and pertinent references are listed. More useful is the in-progress species by species reports of The Birds of North America (1993 onward). Published as stand-alone summaries of each species' natural history, this partially completed work incorporates the latest findings on habitat, breeding phenology, demography and populations, conservation, management, and references.

A Louisiana Breeding Bird Atlas showing distribution of all breeding birds in the coastal zone is in the early stages of preparation. Hamel's 1992 The Land Manager's Guide to the Birds of the South briefly summarizes the key habitats, sample breeding densities, food habitats, and pertinent references for all breeding species of Louisiana coastal birds. Charts showing favored water types (fresh, brackish, salt, all) for all species is particularly valuable for marsh managers. Appendix I presents a more extensive overview of information sources and life history profiles.

Relative to marsh management, however, not a great deal of research has been done. Sprunt (1967) reported on the more commonly seen species as well as characterized the then existing and probable relationship between several birds groups and marshes. He characterized the Louisiana and Texas coastal marshes as basic to the well being of wading

birds in particular and many others species as well. Migrating shorebirds and wading birds can be considered seasonally benefitted indirectly by water level manipulations. Passerine usage of marsh areas can be increased if water levels are maintained at level that induce the growth of weedy areas at the marsh margin and/or by the presences of shrubs or trees.

Waterfowl have been and will continue to be a resource of interest, often targeted for management. Clearly, when targeted for management they are direct beneficiaries. As a group they may be considered indirect beneficiaries of management that focuses on preventing, slowing, stopping of reversing marsh loss.

The focus of the historical interest in Louisiana's coastal marsh mammals has been fur production and harvest. Lowery (1974) dedicates a chapter early in his book to that subject. His book itself is a compendium of anatomical, behavorial, physiological and, to a lesser degree, ecological profiles of Louisiana's mammalian species. O'Neil (1949) published what is generally regarded as the benchmark work on the biology of the muskrat in coastal Louisiana. Cattle grazing occurs in coastal marshes but has not been a stipulated reason to manage marshes.

The socioeconomic complexities of coastal Louisiana have long been appreciated but remain to be comprehensively characterized. Davis (1983) and Davidson and Chabreck (1989) are examples of the more traditional perspective on the socioeconomics of coastal Louisiana marsh dependent resources. However, the economics of modern environmental management, including efforts focusing on restoration, is an emerging, dynamic discipline only now coming into its own in terms of economic theory and modeling (Turner, Pearce and Bateman 1993). The discipline has acknowledged the social implications of competing users groups. Some of those user groups have become very proactive (Gagliano and Roberts 1987, Chabreck 1994), but valuation is still the subject of theoretical discussion and measurement techniques are imprecise in some cases. Applied economics have focused on valuing some of the commercially and/or recreationally important species, and that trend continues but with a theoretical overtone (Shirley 1995). If a comprehensive study exists that quantitatively documents the socioeconomic implications of managing Louisiana's coastal marshes, any such study was not readily retrievable during this analysis. Thus, traditional profiles of employment, businesses, population trends and growth expectations, taxes, flood stage reports, hunter days, hunter experiences (e.g., Gan and Luzar 1992), license sales, fur harvests and prices and fish landings represent the bulk of the readily available

information. Those data, however, leave us poorly prepared to profile and predict the socioeconomic concerns specifically associated with managing Louisiana's coastal marshes. This is an area in need of detailed study.

Several major collections of papers require special mention. Each collection is another milestone effort in the quest to understand the structure and function of Louisiana's coastal marshes and the effects of our activities, including management, in those marshes over the years. Newsom (1967), Chabreck (1973) and Day et al (1978) archived the proceedings of symposia. General characterizations of Louisiana's hydroclimate, geological processes, recent sedimentary history, nearshore hydrologic processes, and synoptic treatments of the biology, ecology and socioeconomic resources are presented in Gosselink, Cordes and Parson (1979) for the Chenier Plain marshes and Gosselink (1984) for the Delta marshes. Duffy and Clark (1989) present a collection of research and overview papers. Several are particularly noteworthy because they demonstrate how interpretational study efforts (e.g., LeBlanc, 1989; Gagliano and Wicker 1989; Murphy 1989, Pezeshki et. al., 1989), observational study efforts (e.g., Reed 1989), and manipulative or experimental study efforts (e.g., Mendelssohn and McKee (1989), individually and collectively, have advanced our insight into the structure and function of Louisiana's coastal marshes. Cahoon and Groat (1991) reported on the findings of a multiagency effort to discern the relationship between marsh management and selected attributes of Louisiana coastal marshes coast-wide by looking at the available historical records and performing short-term field investigations. Sweeney et. al. (1990) and Cahoon (1991) illustrate what can be accomplished despite the complexity and unavoidable procedural constraints that are inherent to studying the effects of management. However, those three papers also equally well illustrate the limitations, shortcomings and dangers associated with having to rely upon observational data and short-term field (one-to -two years) monitoring/data collection efforts to infer cause and effect relationships that serve as the basis for formulating accurate representations of longer-term system responses to management. The same caution would seemingly apply to short-term (less than three years) permit monitoring data sets.

Readers are urged to refer to the above-mentioned publications, and scan the References/Literature Cited section of this PHMEIS, if more insight is required.

### 4.8. **Where Science And Society's Interests Meet**

Marsh losses have and will continue to affect individuals

from various walks of life as well as the social and economic dynamics of communities and the State of Louisiana. Public concern about marsh losses has also already precipitated amendments to the Louisiana state constitution and captured the attention of the Congress of the United States that recognizes the loss of Louisiana's coastal wetlands as a problem of national importance.

First documented in the 1970's, Louisiana's once self-sustaining, vast coastal marshes were disappearing at an alarming rate (Chabreck 1972, Chabreck and Linscombe 1982; Gagliano et al 1981). Subsequent study of those losses has revealed that the marsh loss rate accelerated and decelerated in correspondence with our past activity spurts (Dunbar, Britsch and Kemp 1990, 1992; Britsch and Kemp 1990) and the marsh loss patterns are very strongly and directly linked with our past actions (Viosca 1928; Turner 1987). Kuecher (1995) has reported on the influence subsurface and near surface geomorphology can play on land loss rates, especially relative to wetland loss in Terrebonne and Lafourche Parishes, which may be useful explaining areas of historic loss and identifying areas with higher potentials for future loss.

With what is socially and economically at risk, and the apparent unacceptability of disassembling the existing social and economic infrastructure within Louisiana's coastal marshes (CWPPRA), the public has become progressively more concerned and also recognized that the solution to marsh erosion is founded in the biology and dynamics of coastal marshes, particularly their management. The assumption appears to be that if the marsh can be saved the other attributes will take care of themselves.

Accordingly, marsh scientists and managers have become involved in answering questions like how effective will our actions be, what are the biological consequences of management efforts designed to slow, stop or reverse Louisiana's coastal marsh losses and are the biological costs unacceptable relative to the derived benefits. Unfortunately, the marsh scientists and managers that are partners in the effort to slow, stop or reverse Louisiana's coastal marsh losses are unable to give unequivocal answers. They generally can answer only in generalities (Cahoon and Groat 1991). The rate science has studied and documented the natural as well as induced differences in the coastal zone (e.g. Turner, Cahoon and Cowan 1986) have lagged behind society's needs and desires and extends beyond the ready talents and insight of current day managers.

Nonetheless, marsh scientists and managers, and more recently members from the general public (Louisiana Coastal

Wetlands Conservation and Restoration Task Force 1993) are willing to and do participate in making decisions about how best to arrest coastal marsh losses. However, those decision are themselves often sources of controversy among the participants. That's because the best available information about what causes marsh losses and why largely consists of anecdotal evidence and imprecisely and/or yet to be fully studied interrelationships (Cowan, Turner and Cahoon 1988). Moreover, the use of wildlife management practices that historically focused on improving conditions for a few marsh dependent species to offset the factors responsible for accelerating marsh losses over the last 40 years is a new and evolving application of existing technology. Not surprisingly, professional opinions in such cases can, and in the case of marsh management, do differ greatly, which is the basis for the scientific controversy over the biological merits and effectiveness of marsh management. Biological uncertainties only accentuate the different opinions that exist about the social and economic implications of managing marshes and have been the basis for calls for more impact study, inclusive of cumulative impacts (Cowan, Turner and Cahoon 1988), as well as be attentive to other marsh system dynamics (Nyman et al 1993c).

Applicants, permit analysts and other stakeholders must contend with these limitations and realizations as well as directives imposed by society including constraints that require consideration of social and economic factors in the management design process (i.e., Corps Regs and LA DNR-CMD Guidelines).

4.8.1. Agency Actions To Address The Management Of Marshes

4.8.1.1. Non-COE Agencies

Two Federal resource agencies {i.e., US Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS)} are involved principally as commentors on more formalized management proposals, although the FWS does manage marshes within its refuge system and has prepared a draft policy on marsh management but has not released it to the public.

The State of Louisiana has promulgated some general policy level initiatives (Coastal Restoration Technical Committee 1988, Edwards, et al 1995), been involved with some individual management plans to include preparation of monitoring reports (Clark 1989 a,b); attempted to address some site-specific problems (Wetland Conservation and Restoration Task Force, 1990), have up-dated their coastal restoration strategy (Gagliano 1994), and have had a published policy concerning wetland management and hydrologic restoration since 1993 (Good, Clark and Soileau

1993).

The EPA has taken steps to collect information about marsh management (Environmental Protection Agency 1994) in support of an initiative that is intended to produce an agency policy ion marsh management.

Accounts of what the non-COE agencies do when it comes to evaluating permits applications from the perspectives of their respective agency mandates are presented as Appendixes, as indicated.

4.8.1.1.1. US Fish and Wildlife Service (FWS)

This agency's narrative is presented as Appendix B.

4.8.1.1.2. National Marine Fisheries Service (NMFS)

This agency's narrative is presented as Appendix C.

4.8.1.1.3. Natural Resources Conservation Service (NRCS)

This agency's narrative is presented as Appendix D.

4.8.1.1.4. Louisiana Department of Natural Resources (LaDNR)

This agency's narrative is presented as Appendix E.

4.8.1.1.5. Environmental Protection Agency (EPA)

This agency's narrative is presented as Appendix C.

4.8.1.2. COE-NOD

The NOD's procedures in evaluating permit applications for proposals involving management efforts is presented as Appendix G.

4.8.2. General Discussion of NOD's Permit Data

NOD's permit files were not designed to be a platform for broad-ranging analytical efforts such as demanded by this EIS. However, a data base was constructed from those files and was used to characterize chronological trends and to infer correlations relative to: 1) stipulated reason(s) for undertaking management; 2) the marsh types (but not individual acreages by type) included within each permit; and, 3) the geographic scales over which the relationships can be detected.

The permit data base lends itself to general inferences

about project location and historic and current marsh loss rates in as much as marsh restoration is identified as reason to undertake management. The permit data base is a very poor tool with which to infer success of the permitted activity relative to stipulated purpose. Monitoring reports, typically required as a permit conditions, were intended to provide those insights.

4.8.2.1. Compilation

NOD's Regulatory Functions Branch (NOD-RF), within the Operations Division, administers the permit programs applicable to activities and structures affiliated with marsh management.

NOD-RF's listing of permit actions between 1977 and 1995 (April) were transcribed and input into a QuatroPro spreadsheet program maintained by NOD for analysis. The summary statistics and figures referred to in the following narrative were generated within that data environment.

The data were reported by the year a permit was issued, physiogeographic region, hydrologic basin within region, whether the permitted plan was active or passive, had been implemented and by purpose for which management was to be undertaken. An examination of these attributes provides a meaningful basis for characterizing past and future impacts.

Permit issuance does not translate into biological/ecological/socioeconomic impacts on natural systems real-world impacts or effects on coastal marsh systems until a project is implemented. Whatsmore, NOD assumes that permit issuance correlates highly with project implementation. Thus, by extension, permit issuances can be used to approximate impacts and effects. However, NOD recognizes that not all issued permits are necessarily implemented. In the case of marsh management, nearly 18 years has passed since the first permit in NOD's database was issued and an accurate accounting of the status of the issued marsh management permits would be essential for accurate impacts assessments.

Accordingly, between October 1994 and March of 1995 NOD attempted to contact each and every one of the marsh management permittees for the purpose of confirming the status of the projects. At least one and often multiple follow-up contacts were attempted for each initially nonresponsive inquiry. For those permittees that did not respond to our inquiry, NOD assumed that the project had been installed, at least to some appreciable degree. Projects that we were able to confirm had not been initiated/installed and for which the permit had expired

were not carried forward in our acreage tallies.

Appendix A is a presentation of the permit data.

4.8.2.2. Overview

The Plates and Figures referred are presented at the end of this section.

For the 19-year period 1977-1995 (April), NOD initiated evaluations of 117 permit applications for management (Appendix A). Twenty two (totalling 105,225 acres) were subsequently withdrawn from consideration before a final decision was rendered. One (for 520 acres) was denied. Four applications are pending a decision.

A total of 89 permits were issued for management actions in Louisiana's coastal marshes by NOD (Appendix A). Based upon our findings relative to the status of those previously issued permits, we have determined that 76 projects have been/are presumed to be implemented to some degree in seven of the nine hydrologic basins that comprise coastal Louisiana first described by Chabreck (1972) (Tables A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-8, A-9), and later defined in a slightly different configuration (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1993). Those 76 permitted projects encompass 472,271 acres (Table A-10). The location of those projects is presented in Plates 1 through 8.

We began our analysis of the permit data by looking at permit activity over time, as it was our permit issuances over time that alerted us to the potential for possible significant consequences.

Reference Figures 1-4 (A-10, A-11, A-12, A-13), in 1980, 1984 and again in 1991, one or two large acreage permits were issued, noticeably elevating the cumulative numbers of acres in each instance. From 1981 to 1985, the cumulative number of permit issuances increased rapidly and faster than the corresponding accumulated acreage, meaning that average size of the permitted project began to decline. As early as 1986 NOD, NRCS and the DNR agreed there was an apparent need to prepare a programmatic marsh management document, which was formalized in the February 10, 1988, edition of the Federal Register where the Notice of Intent to prepare this EIS was published. Since 1985, the permit issuance rate has remained fairly constant for projects that, on average, have tended to become consistently smaller and overall have averaged about 6,700 acres.

Figures 4-7 (Tables A-13, A-12 and A-22) display the reason

for management over time and between regions and basin within regions. Reference Figure 4, in 1990, marsh restoration surpassed all other purposes and became the management purpose encompassing the most acreage. Since then the amount of acreage managed for waterfowl/marsh restoration has remained second, ahead of waterfowl, and has continued to steadily increase. The amount of acreage brought under management for the single purpose of waterfowl has continued to increase steadily year after year. Figures 5, 6 and 7 show that most of the surge occurred in just two basins [Delta Region: Basin 4 - Lafourche Parish w/l 743 (123,000 acres, 1991), Chenier Region: Basin 9 - Calcasieu Lake 382 (66,000 acres, 1980), Tables A-3 and A-9, respectively]. Other difference between basins and regions can also be seen, especially so in the Delta region (Figure 6).

Figure 8 and 9 (Table A-13) display the relationship between marsh types included in management efforts and time. Clearly, the permit activity in one year can greatly influence the totals. However, projects were permitted almost every year that included both the fresh and intermediate marsh types and only the brackish marsh type. Management projects encompassing the brackish and saltier marsh types were much fewer in number but tended to be large and almost isolated incidents.

Figure 10 (Table A-20) displays the relationship between the reason(s) stipulated for management and the type of marsh(es) encompassed within the permitted management efforts. Purpose and marsh type do not appear to be particularly well correlated but the inclusion of brackish marsh in efforts that encompass more than one marsh type should be noted.

Again reference Figure 10, nearly all of the acreage brought under management for waterfowl-only projects encompassed brackish or fresher marsh types. Marsh restoration efforts also tended to focus on the brackish or fresher marsh types, but also include some appreciable brackish and saltier marsh types. Encompassing more than one marsh type within a management effort was fairly common. Reference Figures 10 -13 (Table A-19), encompassing more than one marsh type within a management effort occurred across both regions as well as basins within regions. Based on an inspection of Figures 10 and 11, a desire to pursue marsh restoration as a single project purpose is suggested but so, too, is a desire to restore marsh for waterfowl enhancement purposes.

Reference Figures 12 and 13, differences between basins within regions is suggested but not strongly so. For example, the focus of management efforts in Basin 1 seems to

be saltier marsh types than have been brought under management in Basin 7. That difference may truly exist but only so because Basin 7 is overall fresher than Basin 1.

NOD also computed and examined averages and those data are presented as Figures 14, 15 and 16 (Table A-22). Our conclusion was that averages could not be used to consistently and reliably address impacts and effects. For example, a single large project in each of two basins (Basin 4 - 123,000, Basin 9 - 66,000) dramatically elevated the average project size in those basins relative to all other basins. And, the distorting effect of vastly different projects sizes in small data sets was even more dramatic when only two or three projects represented the total response for a year, cover type or management purpose. Thus, number of permits, total acreages and percentages are reported.

4.8.2.3. Permit Landscape Patterns

Permitted areas can exhibit patterns over the landscape. When they do, the pattern between projects can be described. If projects have no common boundaries and they are not adjacent to each other they exhibit a *disconnected* pattern. If two or more projects share a common boundary, several patterns are possible. An *adjacency* pattern exists when there is a common boundary between two projects but there isn't a common boundary between three or more projects. An *in-fill* pattern exists when the boundary of a more recently implemented project has a common boundary with several other previously permitted projects. Finally, a *capture* pattern exists when a project is incorporated partly or wholly within a second project.

4.8.2.4. Permit Monitoring

Monitoring has been explicitly required in approximately two-thirds of the permits that have been issued. The decision as to which suite of attributes is to be monitored in what way usually is project-specific. Therefore, not all monitored attributes are measured in identical ways in all cases. However, how often any given attribute is to be monitored and how frequently monitoring reports are to be submitted and reviews undertaken have been approximately the same since the mid-1980's.

4.8.3. Correspondence with Stipulated Purpose

Marsh restoration and improvement of habitat for waterfowl have been cited by managers for years and more recently by permit applicants as independent or combined reasons for wanting to undertake management. The following narrative

summarizes an examination of the relationship between stipulated reason(s) and permitted projects.

From the literature and our permit experience, management focusing on waterfowl habitat improvement is typically undertaken for one or more of the following reasons: 1) improving conditions is - a) aesthetically pleasing and/or b) recreationally and/or economically rewarding (from improved habitat conditions and expanded and reliable access); and/or, 2) is ecologically necessary to forestall reductions of overwintering waterfowl populations. We are not aware of any studies or records addressing aesthetics or the recreational/economic rewards of managed marshes. However, Michot (1995 galley proof) attempted to quantify the relationship between marsh loss in coastal Louisiana and overwintering waterfowl numbers. He was unable to demonstrate any statistical or biological relationships between the numbers of overwintering waterfowl and historic marsh losses in coastal Louisiana. He proposed two explanations as a result of his efforts. Paraphrasing one explanation, absent management, declines in waterfowl numbers might have occurred. Paraphrasing his second explanation, the remaining acres of coastal marsh still exceed the life requisite requirements for food, water and shelter of the overwinter waterfowl populations.

There are no photographic or other records with which to directly measure and quantify the historic relationship between marsh and waterfowl or management efforts and the response of targeted waterfowl. Surrogates often used to infer an improvement are: 1) if and when certain resources used by waterfowl are more numerous or more abundant within the managed area; and, 2) yearly waterfowl use and/or harvest figures from the managed area. However, those surrogates can be highly variable.

Ultimately, NOD concluded it would be fruitless to attempt to identify and quantify meaningful trends relative to overwintering waterfowl numbers within our permit data base.

The maps and photographic records available to NOD may or may not reveal the efficacy of permitted marsh restoration efforts in slowing, stopping or reversing marsh loss because permitted marsh restoration efforts may or may not appear on the maps or be linked with historic marsh losses. Thus, the marsh erosion stipulated in a permit action: 1) could have occurred- a) but on a scale not detected by our marsh loss/erosion data collection techniques, and b) was not reported in monitoring reports; or, 2) did not in fact occur, suggesting the management effort was- a) successful at forestalling anticipated losses, b) use of the term in the context of changing marsh types rather than acreage

conversions, or c) misrepresentation/misunderstanding of the relative emphasis on the stated purpose(s) for the management action. Therefore, NOD acknowledges that comparing marsh restoration as a stipulated purpose and project location with time sequence photographs of Louisiana's coastal marsh loss is merely an index rather than an absolute measure.

Three attributes of marsh loss are of particular interest: 1) how much total loss has occurred; 2) over what time frame has the loss occurred; 3) how does the recent loss rate (1983-1990) compare with the long term average loss rate; and, of relative interest 4) what is/are the suspected reasons for the loss.

The NOD maintains a computerized GIS data base on land loss in coastal Louisiana (see Appendix H). The period of record for that data base is 1932 to 1990. The data are time-sequenced and can be displayed on monitors or print-outs in map form depicting, in different colors, losses that have been recorded. NOD is currently editing those data and preparing versions of those maps for publication, probably in early 1996. Early draft versions of the maps and computer displays were referred to when preparing this portion of this EIS.

4.8.3.1. Delta Region/Basins

4.8.3.1.1. Pontchartrain Basin (Basin 1)

Permit Data Profile

Six permits have been issued and presumed implemented to some degree in this basin (Table ,Plates 1 and 2). Collectively, they encompass 37,490 acres. Additionally, all six include an active water level management component as an integral part of each management plan. Only two permitted areas abut or adjoin each other and they are not hydrologically or operationally linked to each other.

No permits were issued for the singular purpose of marsh restoration.

Waterfowl habitat improvement was the singularly stipulated purpose for two permits collectively involving 14,808 acres (39 % of total) permitted in this basin. One of those project areas (IWW-NO-to Mobile 65-permit issue date 1993), involving 13,974 acres, encompasses an area that exhibited relatively high historic, and measurable and documented conversion of marsh to open water that occurred during the 1932 to 1974 time frame. Those losses are correlated with man's activities and internal marsh losses but shoreline

erosion has persisted since 1932 and been notably rapid. Permit St. Bernard Parish w/l 69 (permit issue date 1987), involving 834 acres (2 % of total), encompasses an area where the recorded loss occurred during the 1958-1974 time frame and appears to be related to shoreline erosion and man-made losses.

Four permits, encompassing 22,682 acres (61 % of total basin permitted acres), were issued with marsh restoration as one of two project purposes. Of those four, only one (St. Charles Ph w/l 156a, 12,640 acres - 34 %, permit issue date 1988) targeted an area that exhibited a relatively high historic, measurable and documented conversion of marsh to open water, most of which appears to be the result of internal erosion. Of the other three, two (permit issue dates 1983 and 1984) encompassed 6,962 acres (about 19 % of the total acres permitted in this basin) and in each case historic, measurable and documented conversion of marsh to open water has hardly occurred. The fourth permit of this group, St. Bernard Ph w/l 33 (permit issue date 1981) encompassed 3,080 acres (about 8 % of the total acres permitted in this basin). That permitted project area has evidenced very little loss since the 1932-1958 time frame when losses associated with man's activities were recorded.

Permit Landscape Patterns

The permit patterns exhibited in this basin are disconnected and adjacency (Plates 1 and 2). Lake Borgne Canal 5 (1983) and Lake Borgne Canal 6 (1984) are adjacent projects. They both employ active management and collectively encompass 6,962 acres of only brackish marsh for waterfowl and marsh restoration. However, marsh loss has hardly occurred in measurable amounts in either of these two areas. These two project areas are not hydrologically or operationally linked to each other.

Permittee Profile

A parish government was issued three permits encompassing 10,042 acres (27 %) between 1981-1984 for waterfowl/marsh restoration management projects. Corporate landowners were issued the three other permits, encompassing 27,448 acres (73 %) between 1987 and 1993. Just a little more than half (14,808 acres) was managed for waterfowl by the corporate permittees. Overall, four of the six permittees focused on waterfowl/marsh restoration (22,682 acres, 61 %).

Basin 1 Summary

NOD has issued permits for restorative management activities that target marshes with very little recorded historic

losses of acreage. Only about 12,000+ acres of marsh evidencing historic, measurable and documented conversion of marsh to open water have been specifically targeted for restoration efforts.

Active marsh management was the management option of choice. Active marsh management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken by a corporate entity, was multi-purposed (but focuses on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and encompassed brackish or saltier marsh types. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). Our review of our database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.1.2. Breton Basin (Basin 2)

Permit Data Profile

All four permits were issued during the 1982-1983 time frame with both waterfowl and marsh restoration as the stipulated purposes (Plate 3). All four project areas (cumulatively 13,572 acres) encompass marsh where the conversion of vegetated surfaces to open water has been documented and include an active water level management component as an integral part of each management plan.

All the marshes targeted for management experienced predominantly interior losses as recently as 11 or as long as 20 years before the permitted restorative management actions were undertaken. Those losses can be correlated with hydrologic alterations caused by man-made surface landscape features and natural distributary levees and subsidence. Marshes encompassed by St. Bernard Ph w/l 48 still exhibit a relatively high loss rate.

Permit Landscape Patterns

The permit patterns exhibited in this basin are disconnected and adjacency (Plate 3). Permits Caernarvon Canal 1, Bayou Mandeville 2 and St. Bernard Parish w/l 48 exhibit adjacency, were all issued in 1983, employ active management, and collectively encompass 11,313 acres of only brackish marsh for waterfowl and marsh restoration.

Relatively high rates of historic marsh loss has occurred in these three adjacent areas. These three permits are not hydrologically or operationally linked to each other.

Permittee Profile

A corporate entity was issued the first of the four permits issued in this basin. That first permit was issued in 1982 and encompassed 2,260 acres (17 % of total). A parish government was issued the other three in 1983 encompassing 11,312 acres (83 %). All permittees focused on waterfowl/marsh restoration. All four areas have exhibited relatively high rates of historic land loss.

Basin 2 Summary

All four permits issued by NOD for management projects in this basin do involve marshes with documented historic losses. They also include a waterfowl habitat improvement as a stipulated project purpose.

Every restorative effort involves marshes that exhibited losses that occurred a decade or more ago, but only one encompasses a marsh that even over the last 11 years has continued to evidence relatively high marsh loss rates. Two explanations are possible: 1) management on three out of four has been successful or management on three out of four was unnecessary from the standpoint of addressing current marsh loss.

Active management was the management option of choice. Active management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken by a government entity, was multi-purposed (but focused on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and encompassed brackish or saltier marsh types. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). Compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.1.3. Barataria Basin (Basin 4)

Permit Data Profile

Fifteen permits have been issued and are presumed

implemented to some degree in this basin (Table , Plate 4). Collectively, they encompass 235,315 acres.

Four permits have been issued since 1983 for the singular purpose of marsh restoration. Collectively, they encompass 138,176 acres (59 % of the total permitted acres in this basin). One, a 2,950-acre project, involves active water level manipulations. The three others involve passive management. A single project (Lafourche Parish w/l 743) accounts for 123,000 acres of the total 138,176 acres managed solely for restoration. The management option of choice for three of the four marsh restoration projects is passive marsh management encompassing 138,176 acres (57 % of total acres permitted). The first permit issued in this basin solely for restoration was Lafourche Parish w/l 480 (2,950 acres, active management) in 1984. Permits Bayou Des Allemands 110 (5,976 acres) and Lafourche Parish w/l 743 and 718 (6,250 acres) were issued in 1985, 1991 and 1994, respectively. Marshes managed under permits 480, 110 and 718 all exhibited relatively high historic loss. The losses recorded in the marshes encompassed permits 480 (brackish/saline marsh types) and 718 (undisclosed marsh type) occurred consistently over the entire period of record. The losses that occurred in the fresh marsh encompassed by 110 were minor. The losses recorded in the marsh encompassed by 743 (fresh/intermediate/brackish marsh types) occurred mostly during the 1958-1983 time frames. It appears that the losses in all these managed areas can easily be attributed to man-induced modifications to the hydrology that increased flooding duration, tidal scour and the incidence of saltwater intrusion.

Waterfowl habitat improvement was the singularly stipulated purpose for two permits collectively involving 51,042 acres (22 % of total). Active marsh management was the management option of choice in both cases. Permit 540 (45,657 acres, permit issue date 1984) encompasses an area with fresh/intermediate/brackish marsh types that exhibited relatively high marsh losses mostly during the 1958-1983 time frames. Shoreline erosion has been a persistent problem along the northern boundary of this managed area but the time frame during which the recorded internal marsh losses occurred were the same time frames during which a petroleum extraction canal system was dredged. Permit Lafourche Parish w/l 733 (5,385 acres, permit issue date 1991) encompasses an area of fresh marsh. Over the period of record, only very little marsh loss has been recorded in the marsh encompassed by this permit.

Research was the single stipulated purpose for two projects that were permitted, encompassing a total of 818 acres (less than 1% of total). Active management was the management

option of choice in both instances. Bayou Des Allemands 107 (678 acres, permit issue date 1985) encompasses fresh marsh that has evidenced very little marsh loss over the period of record. Jefferson Parish w/l 229 (140 acres, permit issue date 1991) is located in a larger brackish marsh area that has exhibited a relatively high loss rate especially during the 1932 to 1974 time frames, the same time frames during which a petroleum extraction canal system was dredged.

Seven permits, collectively encompassing 45,279 acres (19 % of total), were issued with marsh restoration and waterfowl habitat improvement as the stipulated project purposes. Active management was the management option of choice for five (encompassing 37,423 acres - 16 %) of the seven permits. The five were Lafourche Parish w/l 547 (3,573 acres, permit issue date 1984, brackish/saline marsh), Lafourche Parish w/l 517 (12,300 acres, permit issue date 1984, saline marsh), Lafourche Parish w/l 577 (8,700 acres, permit issue date 1985, brackish/saline marsh), Jefferson Parish w/l 192 (450 acres, permit issue date 1989, brackish marsh), and Jefferson Parish w/l 215 (12,400 acres, permit issue date 1990, intermediate marsh). Passive management was the management option of choice for the other two projects (encompassing 7,856 acres - 3 %). Those permits were Barataria Bay Waterway 226 (1,190 acres, permit issue date 1981, brackish marsh) and Lafourche Parish w/l 529 (6,666 acres, permit issue date 1985, brackish marsh). Marsh loss in every one of these seven management areas has been relatively high during the period of record. Interior marsh losses in the area encompassed by Barataria Bay Waterway 226 were very extensive during the 1932-1958 time frame, but continued through 1983. Marsh areas encompassed by permits Jefferson Parish w/l 192, and Lafourche Parish w/l 517, 547, and 577 are within larger areas where interior marsh losses have been ongoing since 1932 but tended to occur mostly during the 1958-1983 time frames. Recorded losses in the vicinity of permits 517, 547 and 577 initially occurred during the 1932-1958 time frame, which was the same time frame within which petroleum extraction canals were first dredged from Bayou Lafourche. During the 1958-1974 time frame some of those canals were extend easterly. Those newer canals more directly linked the interior marshes to the more dynamic hydrology of the Gulf of Mexico. Historic marsh loss in Lafourche Parish w/l 540 is either man-made, due to the failure of an agricultural endeavor (1958-1974 time frame and the dredging of a petroleum extraction canal system during the 1932-1974 time frame or the result of persistent shoreline erosion. Losses in Jefferson Parish w/l 215 are the result of long term (1932 to present) shoreline erosion, dredging of petroleum extraction canals during the 1930-1970's time frames and internal marsh losses during the 1974-1983 time frame.

## Permit Landscape Patterns

The permit patterns observed in this basin are disconnected, adjacency, and internal capture (Plate 4).

One group of two permits comprise the adjacency situation. The group is comprised of permits Lafourche Parish w/l 517 and 547. The two permit areas are only administratively different, at the request of the two land owners involved. The two permit areas share a common purpose (i.e., waterfowl/marsh restoration), are hydrologically indistinguishable and, thus, are operated as a single project area of 15,873 acres employing active management. The managed marsh has evidenced a relatively high rate of interior marsh loss.

Permit Lafourche Parish w/l 743 was issued to Lafourche Parish in 1991. The 123,000-acre project site is bounded on the north by US Highway 90, on the west by the Bayou Lafourche ridge, on the south by a pipeline canal and on the east by natural lake and bayou shorelines and manmade structures. This passively managed project site encompasses the entire westcentral portion of the hydrologic basin. It completely surrounds a 678-acre actively managed research area (Bayou DesAllemands 107), contacts on three sides a 5,385-acre actively managed waterfowl management project area (Lafourche Parish w/l 733), and incorporates an actively managed 45,657-acre waterfowl management project area (Lafourche Parish w/l 540). The waterfowl management project areas can be operated independently of the hydrology elsewhere in the 743 project area. However, the hydrology of the research area may not be independent of the hydrology in the 743 project area.

The wetlands between Lake Salvador and the upper reaches of Barataria Bay are a physical landscape feature that separates the basin into two portions. The marshes north of this area are historically fresher and are subjected to buffered Gulf forces. The more southerly marshes are subjected to greater Gulf hydrodynamics. The marsh area brought under management by Lafourche Parish w/l 743 and Jefferson Parish w/l 215 collectively encompass a substantial fraction of that landscape feature between the two portion of the basin.

## Permittee Profile

A single permit (encompassing 123,000 acres, 52 %) was issued to a parish government in 1991. The purpose of the project was marsh restoration of fresh/intermediate/brackish marsh. Localized erosion has occurred in some portions of

the project area. Passive management (later characterized as hydrologic restoration) was employed.

Two permits (encompassing 12,540 acres, 5 %) were issued to Federal government agencies during the 1990-1991 time frame. Research and waterfowl/marsh restoration were the stipulated project purposes. Relatively high rates of erosion have been recorded in both project areas. Both projects employed active management.

Three permits (encompassing 9,650 acres, 4 %) were issued to individuals or other private entities between 1983 and 1994. All stipulated marsh restoration was a project purpose. Relatively high rates of historic erosion have been recorded in all three project areas.

Three permits (encompassing 16,215 acres, 7 %) were issued to one oil and gas firm in 1984 and 1985. All had marsh restoration as a project purpose. All three project areas have exhibited relatively high rates of marsh loss. Both active management (targeting brackish/saline marsh) and passive management (targeting a fresh as well as a brackish marsh) were employed.

Six permits were issued to corporate interests between 1981 and 1991. They collectively encompassed 73,910 acres (31 %). Management for waterfowl encompassed 51,042 acres, waterfowl/marsh restoration encompassed 22,190 acres and research encompassed 678 acres. Relatively high rates of historic marsh losses were recorded within each of the four project areas for which restoration was one stipulated project purpose. The two other project areas exhibited little loss over the period of record. The management option of choice was active management (encompassing 72,720 acres), involving all four marsh types.

Basin 4 Summary

Active management was the management option of choice. Active management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken by a corporate entity (although recent government involvement accounts for more managed acres), was multi-purposed (but focuses on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and encompassed some brackish marsh. The historic permit data base was uninformative about the

success any project achieved relative to stipulated project purpose(s). A review of our permit database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.1.4. Terrebonne Basin (Basin 5)

Permit Data Profile

Fourteen permits have been issued and are presumed implemented to some degree in this basin (Table , Plate 5). Collectively, they encompass 42,148 acres.

Four permits have been issued since 1984 for the singular purpose of marsh restoration. Collectively, they encompass 20,656 acres (49 % of the total permitted acres in this basin). Two projects, totaling 12,374 acres (Falgout Canal 2 and Terrebonne Ph w/l 991), involve active water level manipulations. The two others (Terrebonne Ph w/l 625 and 953), totaling 8,282 acres, involve passive management. All four permits encompass marshes that exhibit historic losses. For permit Terrebonne Ph w/l 625 (permit issue date 1984) the majority of the loss occurred during the 1958-1974 time frame following the initial excavation of a petroleum extraction canal system during the 1930-1958 time frame and that was expanded during each of the subsequent time frames. This area was identified to be located within a larger area that evidenced a high rate of interior loss. For permits Terrebonne Ph w/l 953 (permit issue date 1991) and 991 (permit issue date 1994) and Falgout Canal 2 (permit issue date 1989) the majority of the loss occurred continuously during the 1932-1983 time frames and consisted largely of high rates of shoreline erosion and internal marsh loss, respectively. No relationship was apparent between chosen management approach and marsh type, degree of or time since erosion occurred or permit date.

Waterfowl habitat improvement was the singularly stipulated purpose for two permits collectively involving 1,544 acres (less than 4 % of the total). Both involve active water level manipulations. Both projects encompasses areas with little to no recorded historic loss.

Research was the single stipulated purpose for a single project (Bayou LaLoutre 83) that was permitted in 1991, encompassing a total of 340 acres (less than 1% of total). It involved active water level manipulations. It occurs in a larger area that exhibited a high historic loss rate due to man-made and internal marsh losses that largely occurred during the 1958 to 1974 time frame.

The remaining seven permits, encompassing 19,608 acres (47 %

of total) were issued with marsh restoration and waterfowl habitat improvement as the stipulated project purposes. All seven involved active water level manipulations. All but permit Lafourche Ph w/l 675a (1,125 acres, permit issue date 1995) exhibited high rates of historic marsh loss. The exception encompasses an area with little to no recorded marsh loss. Nearly half of the losses recorded for permit area St. Mary Ph 146 (permit issue date 1985) occurred during the 1932 to 1958 time frame with about an equal amount of loss occurring during the 1958 to 1983 time frames due to internal marsh losses. Permit Terrebonne Ph w/l 478 (permit issue date 1982) encompasses a portion of an area that exhibited high internal marsh losses during the 1958 to 1983 time frame. Permits Terrebonne Ph w/l 628, 696, 870 and 943 (permit issue dates 1983, 1984, 1989 and 1990, respectively), all encompass or are part of larger areas exhibiting high rates of historic losses that occurred during the 1958-1983 time frames. Losses were already extensive by the end of the 1958 to 1974 time frame in all but the 943 permit area, where losses are more recent 1974-1983.

Permit Landscape Patterns

The permitted projects in this basin exhibit a disconnected pattern (Plate 5). None of the projects are hydrologically or operationally linked.

Permittee Profile

Four permits (encompassing 15,714 acres, 37 %) were issued to government entities between 1989 and 1991. Marsh restoration was the single stipulated purpose for three of the projects (encompassing 15,374 acres). Active management was the management option of choice for two (encompassing 12,374 acres) of the these three projects. Research was the single stipulated purpose for the fourth project and it employed active management as the management option of choice. Both intermediate and brackish marsh types were brought under management by these management projects. All four areas Three of these projects have exhibited relatively high rates of historic interior marsh loss. Relatively high rates of shoreline erosion were exhibited within the remaining project area.

Four permits (encompassing 6,406 acres, 15 %) were issued to private individuals between 1982 and 1995. Waterfowl was at least one stipulated purpose for all four projects. However, marsh restoration was also a stipulated purpose for three projects (encompassing 5,681 acres). All four projects employed active management as the management option of choice.

Six permits (encompassing 19,853 acres, 47 %) were issued to corporate interests between 1983 and 1990. Marsh restoration and waterfowl were the stipulated purposes for four of the six projects (encompassing acres 13,927 acres), all of which employed active management as the management option of choice. Marsh restoration was the single stipulated purpose for a project encompassing 5,282 acres for which passively management was the management option of choice. All five of these project areas exhibited relatively high historic interior and/or man-made marsh losses. The fresh marsh type comprising more than 50 % of the marsh acreage encompassed by these five permits. Waterfowl was the single stipulated purpose for the remaining project (encompassing 644 acres of fresh marsh) and employing active management as the management option of choice. This project are has exhibited relatively little past loss.

Basin 5 Summary

Eleven permits (97 % of permitted acres) of the 14 permits issued by NOD for management projects in this basin, do involve marshes with documented historic losses for which marsh restoration was at least one stipulated project purpose. Those restorative efforts involve marshes that exhibited losses that occurred during earlier periods of record.

Active management was the management option of choice. Active management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken more often by a corporate entity, focused on addressing marsh losses, was several thousand acres in size, employed active management to achieve the project purpose(s), and encompassed either fresh or intermediate/brackish marsh types. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). A review of our permit database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.1.5. Atchafalaya Basin (Basin 6)

No marsh management permits have been issued in this basin.

4.8.3.1.6. Teche-Vermilion Basin (Basin 7)

## Permit Data Profile

Eleven permits have been issued and are presumed implemented to some degree in this basin (Table , Plate 6). Collectively, they encompass 25,235 acres. Several permitted management areas abut each other but are not hydrologically or operationally linked to each other.

No permits have been issued for the singular purpose of marsh restoration.

Waterfowl habitat improvement was the singularly stipulated purpose for permit Vermilion Ph w/l 151 (640 acres - less than 3% of the total, permit issue date 1983). It involved active water level manipulations and encompassed an area of relatively high historic marsh loss due to man-made and internal losses that occurred in the earlier time frames of record.

Only in this basin were permits issued for more than two stipulated purposes. Furbearer habitat improvement was the exceptional purpose. Of the three permits issued in basin 7 (totaling 6,800 acres) that included furbearers as one of the stipulated purposes, two of those three (accounting for 5,600 acres of the 6,800 acres) also stipulated waterfowl as a project purpose. For consistency, these three permits are reported with the seven other permits that stipulated marsh restoration and waterfowl as project purposes. Accordingly, 10 permits, collectively totaling 24,595 acres (97 % of total) were issued for projects with marsh restoration and waterfowl as the stipulated purposes. Areas encompassed by permits Iberia Ph w/l 84 (4,500 acres - 18 % of total, permit issue date 1983) and Bayou Cassmer 1 (1,100 acres - 4 % of total, permit issue date 1989) exhibit little to no historic losses and both involve passive water level management. The areas encompassed by the eight other permits (totaling 18,995 acres - 75 % of total, permit issue dates spanning the 1981 to 1992 time frame) all involve active water level management and exhibit relatively high rates of historic marsh loss. Those documented losses are correlated with manmade surface features (e.g., excavation of petroleum extraction canal systems, dredged material disposals), singularly and in combination with natural surface landscape features, constructed during the early decades of the period of record.

## Permit Landscape Patterns

Two groups of two permitted projects each and one group of four permitted projects share common boundaries. The projects that comprise the groupings were all permitted at different times (Plate 6).

One grouping is comprised of permits Iberia Parish w/l 84 (1983) and Bayou Cassmer 1 (1989). The projects are operated independently of each other, neither being a subset of the other, but collectively they affect the hydrology of 5,600 acres north of and influenced by the GIWW. The purposes of both projects are marsh restoration, waterfowl and furbearers. Both use passive management but include different marsh types. Appreciable historic marsh losses have occurred only in the 84 project area.

The other grouping is comprised of permits Vermilion Parish w/l 151 (waterfowl) and Vermilion Parish Wetlands 221, 239 and 272 (all waterfowl and marsh restoration). Collectively, this in-fill pattern encompasses 9,665 acres. Permitted in 1983, 1986, 1986 and 1992, respectively, they all use active management. Permits 272, 239 and 221 encompass only brackish marsh (collectively, 9,025 acres). Permit 151 encompasses 640 acres of both fresh and intermediate marsh. Permit 221 (690 acres) authorized initial establishment of a management plan. The other three reestablished or expanded/upgraded prior/existing management efforts (collectively 8,335 acres). All encompass marsh that exhibited relatively high historic marsh loss rates but none of the project areas is hydrologically or operationally linked to each other.

Permittee Profile

One permit (encompassing 640 acres, 2 %) was issued to a government entity in 1983 to actively manage for waterfowl in fresh/ intermediate marsh that exhibited a relatively high rate of historic internal marsh loss.

Six permits (encompassing 14,370 acres, 57 %) were issued to corporations between 1983 and 1989. Waterfowl was at least one stipulated purpose for all six projects. Marsh restoration and waterfowl were the stipulated purpose for all six projects. Passive management was the management option of choice for four projects (encompassing 9,435 acres) involving fresh, intermediate and brackish marsh types. Active management was the management option of choice for the three other projects (encompassing 4,935 acres) involving intermediate and brackish marsh types. Five of the six project areas (encompassing 4,935 acres) have exhibited relatively high historic marsh losses. The sixth project area (encompassing 4,500 acres, passive management) exhibited relatively little historic marsh loss even though marsh restoration was one of the stipulated project purposes.

Four permits (encompassing 10,225 acres, 41 %) were issued to private individuals between 1981 and 1992. Marsh

restoration and waterfowl were the stipulated project purposes for all four projects. Active management was the management option of choice in all four projects. Intermediate and brackish marsh types were the included marsh types. All four of these project sites exhibited relatively high rates of historic marsh loss.

Basin 7 Summary

Nine permits (78 % of permitted acres) of the 11 permits issued by NOD for management projects in this basin, do involve marshes with documented historic losses. However, only eight (75 % of permitted acres) stipulated marsh restoration as at least one project purpose. Those restorative projects targeted marshes that exhibited losses that occurred predominantly in the earlier periods of record.

Once a single project is established, it may serve a role in establishing adjoining projects, or be incorporated into another project. In either case, neither project purposes, water level managements of choice nor affected marsh type were identical, necessitating, in some cases, amendments/adjustments to previously existing projects.

Active management was the management option of choice. Active management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken only slightly more often by a corporate entity than an individual, was multi-purposed (but focuses on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and targeted intermediate and/or brackish marsh types. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). A review of the permit data base revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.1.7. Delta Region/Basins Summary

Of the 56 permits issued since 1977, 50 permits (involving 353,760 acres) are presumed to have been implemented to some degree. Not all stipulated project purposes were pursued in all basins.

Seven permits (14 % of total permits issued in the Delta

basins) were issued for waterfowl as the single stipulated purpose and they encompassed 68,034 acres (19 % of total issued in Delta basins). This single project purpose was pursued only in Basins 1, 4, 5 and 7. Of the seven permits issued for waterfowl-only projects, four also encompassed areas that exhibited relatively high historic marsh losses, collectively amounting to 61,105 acres. Little or no historic loss was exhibited in the three other project areas, encompassing 6,929 acres.

Eight permits (16 %) were issued for marsh restoration as a single stipulated purpose and they encompassed 158,832 acres (45 %). This single project purpose was pursued only in Basin 4 and 5. All project areas exhibited relatively high historic marsh losses.

Thirty-two permits (64 %) were issued for waterfowl/marsh restoration as combined project purposes and they encompassed 125,736 acres (36 %). Projects with these combined purposes were pursued in Basin 1, 2, 4, 5 and 7. Collectively, 108,969 acres (29 projects) exhibited relatively high rates of historic loss. Collectively, 16,767 acres (three projects) exhibited little to no historic loss.

Three permits (6 %) were issued for research and encompassed 1,158 acres (less than 1 %). This single project purpose was pursued only in Basin 4 and 5. Collectively, 480 acres (two projects) exhibited relatively high rates of historic loss. One 678-acre project area exhibited little to no loss.

Forty permits (80 %), encompassing 284,568 acres (80 %), were issued for projects that stipulated marsh restoration as at least one project purpose. Collectively, they encompassed 267,801 acres (37 projects) where documented marsh losses were relatively high.

Active management was the management approach of choice for 38 projects (76 % of total in the Delta) and encompassed 192,821 acres (55 %). Active management was employed regardless of marsh type, cause of erosion, project purpose or time since erosion occurred. Passive management was the other approach of choice including one project permitted in 1991 encompassing 123,000 acres.

Basins 4 and 7 evidence the only instances where there may be an interaction between permitted project areas, either by their relative positions one to another or by smaller areas being partly or completely surrounded by another project.

The "typical" historic project in the Delta basins was

undertaken only slightly more often by a corporate entity than an individual, was multi-purposed (but focuses on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and tended to target only slightly more often intermediate and/or brackish marsh. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). A review of our permit database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.2. Chenier Region/Basins

4.8.3.2.1. Mermentau Basin (Basin 8)

Permit Data Profile

Fifteen permits have been issued and are presumed implemented to some degree in this basin (Table , Plate 7). Collectively, they encompass 46,031 acres.

Four permits have been issued since 1983 for the singular purpose of marsh restoration. Collectively, they encompass 18,114 acres (39 % of the total permitted acres in this basin). Two projects, totaling 10,750 acres (23 % of total) involve active water level management {Mermentau River 151 - 4,000 acres (9 %), permit issue date 1983; Cameron Ph w/l 906 - 6,750 (15 %), permit issue date 1990}. The two others, totaling 7,364 acres (16 % of total) involve passive management {North Bayou 1 - 4,100 acres (10 %); Creole Canal 2 - 3,264 acres (7 %)}, permit issue date 1984}. The area encompassed by Mermentau River 151 exhibited very little loss all of which occurred during the 1958 to 1974 time frame. Marsh losses in the three other areas were relatively high and related to internal losses correlated with disrupted surface water flow patters but occurred at different times. Most of the recorded loss in 906 occurred during the 1958-1983 time frames. Most of the recorded losses for North Bayou 1 occurred during the 1932 to 1974 time frames but additional losses were recorded during the 1974-1983 time frame. Losses recorded in the Creole Canal 2 area occurred during the 1953-1983 time frames.

Waterfowl habitat improvement was the singularly stipulated purpose for three permits collectively involving 2,098 acres (4 % of the total). Two of the three (totaling 1,819 acres) involved active water level management {Cameron Ph w/l 770 - 400 acres (1 %), permit issue date 1986; Cameron Ph w/l 887 - 1,419 acres (3%), permit issue date 1990}. However, one permit was issued with waterfowl and furbearers as the stipulated project purpose {Little Pecan Bayou 5 - 5,000

acres (11 %), permit issue date 1977 for active management). Because marsh restoration was not a stipulated project purpose, it will be reported with the waterfowl only projects. Accordingly, three permits were issued for projects with waterfowl or waterfowl and furbearers as the stipulated purposes. Collectively, they encompassed 12,098 acres (26 % of total). Permits Little Pecan Bayou 5 and Cameron Ph w/l 887 encompass marshes that have exhibited relatively high losses that mostly occurred during the 1932 to 1974 time frames.

Seven permits, encompassing 20,819 acres (45 % of total) were issued with marsh restoration and waterfowl habitat improvement as the stipulated project purposes. All seven involved active water level manipulations. The marsh encompassed by permit Schooner Bayou 7 (3,700 acres - 8 %, permit issue date 1982) has evidenced losses characterized as minimal over the period of record. Losses in all other permitted areas were characterized as moderate to high. Relatively high internal marsh losses were recorded in four permitted project areas. In permit areas Vermilion Ph w/l 197 (3,820 acres - 8 %, permit issue date 1984), Vermilion Ph w/l 220 (2,260 acres - 5 %, permit issue date 1985), and Vermilion Ph w/l 252 (6,296 acres - 13 %, permit issue date 1989) were attributed to disrupted surface water drainage patterns through earlier modifications to tidal dynamics and water chemistry. In permit areas Vermilion Ph w/l 260 (405 acres - less than 1 %, permit issue date 1990) and Cameron Ph w/l 839 (960 acres - 2 %, permit issue date 1988) recorded losses appear to have occurred in or near impounded areas. In all cases, the recorded losses occurred during the 1958 to 1983 times frames with about equal loss during the two time periods of record. Moderate internal marsh loss was recorded in permit area Vermilion Ph w/l 200 (3,378 acres - 7 %, permit issue date 1984) and related to altered hydrology.

Four projects, encompassing 15,974 acres, were permitted that represented an attempt to initiate a new management presence. Passive management was the chosen approach for only one of those projects (encompassing 3,264 acres). Seven projects, encompassing 17,340 acres, were permitted that represented an attempt to reacquire former management capabilities or perpetuate/upgrade existing management capabilities. Passive management was the approach of choice for only one of those projects (encompassing 279 acres).

Permit Landscape Patterns

The permit patterns observed in this basin are disconnected, adjacency, and internal capture (Plate 7).

Two groups of two permitted projects each and one group of three permitted projects share common boundaries. The projects that comprise the groupings were all permitted at different times.

One grouping is comprised of permits Mermentau River 151, Creole Canal 2 (1984), and Cameron Parish W/l 710. The projects are operated independently of each other, neither being a subset of the other, but collectively they control the hydrology of 7,543 acres south of the Grand Chenier Ridge and west of the Mermentau River. Marsh restoration is the purpose for two projects (affecting 7,264 acres). Waterfowl management is the purpose for one project (affecting 279 acres). Active water level management affects 4,279 acres. Appreciable historic marsh losses have occurred only in the Creole Canal project area (3,264 acres). This pattern of permitting is termed adjacency with in-fill.

A second grouping is comprised of permits North Bayou 1 (1983) and Vermilion Parish w/l 252 (1989). The purpose of both projects is marsh restoration. The affected areas have a demonstrated history of marsh loss. The North Bayou 1 structure (passive water management) was an integral component of the 252 management plan (active water management). Accordingly, the management regime of the North Bayou 1 structure was adjusted and integrated into the active management regime for the 252 management plan. The integrated management program affects the hydrology of 10,396 acres of marsh between the Grand Chenier Ridge and the Gulf of Mexico beach ridge and bounded by formerly existing levees on the east and west. After integrating the two projects, the integrated management area also became the design discharge/receiving area for fresh water drawn by pump from a canal system linked to White Lake. This permit pattern is called internal capture.

The third grouping consists of Vermilion Parish w/l 220 (1985, 2,260 acres, waterfowl) and Vermilion Parish w/l 260 (1990, 405 acres, waterfowl/marsh restoration). These two active water level management projects are operated independently of each other, neither being a subset of one or the other. Collectively, they control the hydrology of 2,665 acres. Both project areas have a history of recorded marsh loss. Both project areas used/rehabilitated previously existing man made surface features to define hydrologic boundaries. This permit pattern is termed adjacency.

Permittee Profile

Four permits (encompassing 11,924 acres, 26 %) have been

issued to government entities between 1982 and 1988. Marsh restoration was at least one of the stipulated project purposes for all four permits. However, historic marsh losses in two of these project areas (3,700 acres, waterfowl/marsh restoration; 4,000 acres, marsh restoration) were characterized as minimal over the period of record. Historic losses in the other two areas were characterized as relatively high. Fresh, intermediate and brackish marsh types were brought under management by these projects. Active management was the management option of choice collectively affecting 8,660 acres of marsh of all three types.

Four permits (encompassing 7,380 acres, 16 %) were issued to private individuals. Waterfowl was the single stipulated project purpose in three of those project areas (encompassing 6,975 acres) of which 6,696 acres were subjected to active management and the management option of choice. Fresh, intermediate and brackish marsh types were brought under management by these projects. All of these project areas have also evidenced moderate to relatively high historic marsh losses.

Seven permits (31,604 acres, 67 %) were issued to a total of three corporations between 1977 and 1990. Marsh restoration was at least one of the stipulated project purposes for six permits (encompassing 26,604 acres, of which 22,504 acres were subjected to active management as the management option of choice). Six of the seven project areas (encompassing 22,226 acres) exhibited relatively high rates of historic interior marsh loss. The seventh area exhibited moderate historic interior marsh loss.

Basin 8 Summary

Twelve permits (80 % of permitted acres) of the 15 permits issued by NOD for management projects in this basin, do involve marshes with documented historic losses. However, only 10 (67 % of permitted acres) stipulated marsh restoration as at least one project purpose. Those restorative projects targeted marshes that exhibited losses that occurred for a decade or more prior to action being taken.

Once a single project is established, it may serve a role in establishing adjoining projects, or subsequently be incorporated into another project. In either case, project purposes as well as water level managements of choice have not been identical, necessitating amendments/adjustments.

Active management was the management option of choice. Active management was apparently perceived to be effective

at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken by a corporate entity, was multi-purposed (but focuses on addressing marsh losses), was several thousand acres in size, and employed active management to achieve the project purpose(s). The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). A review of the permit database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.2.2. Calcasieu-Sabine Basin (Basin 9)

Permit Data Profile

Eleven permits have been issued and are presumed implemented to some degree in this basin (Table , Plate 8). Collectively, they encompass 92,480 acres and all involve active management. Because of the truncated land loss data base, a discussion of permit 20051 is not presented but acreage representations will include the 1,200 acres that correspond to permit 20051.

Only one permit has been issued since 1980 for the singular purpose of marsh restoration. Permit Calcasieu Lake 382 encompasses 67,200 acres (73 % of the total permitted acres in this basin, permit issue date 1980). The project is also commonly referred to as the Cameron-Creole Watershed Project. The area has exhibited relatively high levels of historic marsh loss most of which occurred in the 1954 to 1978 time frame. However, considerable marsh loss continued during the 1978-1983 time frame. Localized loss in the extreme northeastern corner apparently continued during the 1983 to 1990 time frame. These interior marsh losses were largely attributed to alterations of the natural hydrology that increase relative to water levels, increase tidal scour or lead to salt water intrusion.

Waterfowl habitat improvement was the singularly stipulated purpose for four permits collectively involving 8,223 acres (less than 9 % of the total). The marsh encompassed by Calcasieu Parish w/l 67 (35 acres, intermediate/brackish marsh) exhibited little to no loss during the period of record. The marshes encompassed by Black Lake 30 (768 acres, 1982, fresh/intermediate), Cameron Parish w/l 744 (6,620 acres, 1986, fresh/intermediate marsh) and Cameron parish w/l 863 (800 acres, 1991, brackish marsh) exhibited relatively high historic losses, nearly all of which

occurred during the 1953-1974 time frame, but for different apparent reasons. Subsidence was identified as a very likely cause of marsh loss in permit 30. Marsh losses in permit areas 744 and 863 appear to be the result of altered hydrology that resulted in relatively higher water levels, heightened tidal scour, or salt water intrusion.

One permit {Cameron Parish w/l 611 (1984, active management) was issued for a crawfish operation (listed as mariculture) affecting 35 acres of brackish marsh.

Four permits, encompassing 17,022 acres (18 % of total) were issued with marsh restoration and waterfowl habitat improvement as the stipulated project purposes. They were Oyster Bayou 7 (1983, 1,850 acres of fresh/intermediate marsh), Cameron Parish w/l 832 (1991, 1,373 acres of fresh/intermediate marsh), Cameron Parish w/l 923 (1992, 7,224 acres of brackish/saline marsh), and Cameron Parish w/l 963 (1992, 6,575 acres of fresh/intermediate marsh). All four project areas have exhibited relatively high rates of historic marsh loss, especially during the 1958-1974 time frames, with some relatively smaller amounts of loss recorded in subsequent time frames in the Oyster Bayou 7 (continued internal losses) and Cameron Parish w/l 923 (shoreline erosion), mostly reflective of alterations of natural hydrology that elevate water levels, allow tidal scour, or lead to salt water intrusion.

Permit Landscape Patterns

The permit patterns observed in this basin are disconnected and adjacency (Plate 8). Two adjacent permit groups exist.

Five permits comprise one group of adjacent permits while two permits comprise another group. Black Lake 30 (1982), Cameron Parish w/l 744 (1986), Cameron Parish w/l 832 and 863 (1991), and Cameron Parish w/l 963 (1992) comprise the adjacent permit group. Marsh restoration was a stipulated purpose for all but Cameron Parish w/l 863 (waterfowl). The projects that comprise this group are not hydrologically or operationally linked and the last four were implemented in rapid-fire succession. The five permits as a group have created a crescent of adjoining, actively managed areas that follow the former Black Lake shoreline. Although the hydrology and operation of these projects are independent of one another, their geometry: 1) compliments the hydrologic effectiveness of several other management structures along the western shoreline of Calcasieu Lake; and, 2) reduces/eliminates the influence of Calcasieu Lake on more interior marshes. Furthermore, with the issuance of Cameron Parish w/l 963, the Cameron Parish w/l 863 management area became a contained, smaller area (800 acres) subordinate to

the management scheme associated with Cameron Parish w/l 963 (6,575 acres).

The second group consists of two permits, collectively affecting 9,074 acres, both issued for marsh restoration/waterfowl. One is Oyster Bayou 7 (1,850 acres, 1983). The other is Cameron Parish w/l 923 (7,224 acres, 1992). Collectively, this group: 1) encompasses about one-half of the wetland area between Calcasieu Pass and LA Highway 27 south of Calcasieu Lake's West Cove; and, 2) exhibits historic marsh loss.

Permittee Profile

Three permits (encompassing 73,775 acres, 80 %) were issued to government entities between 1980 and 1985. Marsh restoration was at least one stipulated project purpose for all three projects. All three project areas have experienced relatively high rates of historic interior marsh loss. All four kinds of marsh were collectively brought under active management by these projects.

Five permits (encompassing 17,835 acres, 19 %) were issued to corporations, three of which are all and gas firms, between 1982 and 1992. Waterfowl was at least one of the stipulated projects purpose in all five project areas but marsh restoration was a stipulated project purpose for three projects encompassing 9,207 acres. All five project areas exhibited relatively high historic interior marsh losses.

Three permits (encompassing 870 acres, less than 1 %), were issued to private individuals between 1984 and 1992. Waterfowl in two cases and crawfish farming in the third were the stipulated project purposes. A relatively high historic internal marsh loss rate was exhibited in one project area encompassing 800 acres.

Basin 9 Summary

Nine permits (81 % of permitted acres) of the 11 permits issued by NOD for management projects in this basin, do involve marshes with documented moderate to relatively high historic losses. All nine stipulated marsh restoration as at least one project purpose. Nearly all targeted marshes exhibited losses dating back at least a decade and often more. The two other permits encompassed marsh areas that exhibited little or no historic loss.

Once a single project is established, it may serve a role in establishing adjoining projects or it may or may not be influenced by other projects. Over time, the positioning of otherwise unrelated projects one-to-another has created a

new landscape feature with hydrologic consequences to a formerly permitted area as well as two large marsh areas. One was formerly managed. The other was never managed. By bringing adjacent areas under management, or by bringing very large tracts of wetlands under management, the hydrologic results can also extend beyond the boundaries of the individual permitted areas.

Active management was the management option of choice for all permitted projects. Active management was apparently perceived to be effective at achieving waterfowl and/or marsh restoration goals, and was implemented regardless of project purpose, targeted/included marsh type(s), reason(s) for/amount of erosion, or time frame over which erosion occurred.

The "typical" historic project was undertaken by a government entity, was multi-purposed (but focused on addressing marsh losses), was several thousand acres in size, and employed active management to achieve the project purpose(s). The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s). A review of the permit database revealed that compliance with permit conditions requiring monitoring and report submittals was poor.

4.8.3.2.3. Chenier Region/Basin Summary

Twenty-six permits were issued from 1977-1995(April), involving 138,511 acres. Eight permits (31 % of total permits issued in the Chenier basins) were issued for waterfowl as the single stipulated purpose and they encompassed 10,321 acres (8 % of total issued in Chenier basins). Six permits (23 %) were issued for marsh restoration as a single stipulated purpose and they encompassed 85,314 acres (62 %). Eleven permits (42 %) were issued for waterfowl/marsh restoration as combined project purposes and they encompassed 37,841 acres (36 %). One permit (4 %) was issued for a crawfish operation encompassing 35 acres (less than 1 %). No permits were issued for research.

Seventeen permits (59 % of total) were issued for projects that stipulated marsh restoration as one purpose. Collectively, they encompassed 123,155 acres (89 %). All seventeen project areas encompassed marshes where documented marsh losses were relatively high.

Of the eight permits issued for waterfowl-only projects, none encompassed areas with historic marsh losses characterized as either moderate to relatively high.

Active management was the management approach of choice in all project areas. It was employed regardless of marsh type, cause of erosion, project purpose or time since erosion occurred.

Both basins evidenced the potential for interaction between permitted project areas, either by their relative positions one to another or by smaller areas being partly or completely surrounded by another project. The potential is considered much higher in basin 9.

A "typical" historic project in the Chenier basins was multi-purposed (but focused on addressing marsh losses), was several thousand acres in size, employed active management to achieve the project purpose(s), and targeted intermediate or saltier marsh types. A "typical" applicant differed between basins. The historic permit data base was uninformative about the success any project achieved relative to stipulated project purpose(s).

4.8.3.2.4. Coastwide Summary

Projects clearly tended to be located within or encompass areas that exhibited relatively high loss over the period of record. That trend was observed regardless of stipulated project purpose(s). Less than 20,000 acres of marsh (of the 492,271 acres permitted) have been brought under management without some history of relatively high historic losses.

In basins 1, 2, 5, 7 and 8, project patterning suggested that projects addressed individual, site-specific management interests. The corresponding implications, therefore, would likely extend only minimally, if at all, beyond the boundaries of the individual project areas.

In basins 4 and 9, where historic marsh losses have been most extensive, projects also addressed site specific issues but the relative position of the projects suggests the potential for implications that may extend beyond the footprints of the projects possibly than just site specific implications.

A "typical" historic project was undertaken by a corporate or government entity, was multipurposed (but focused on addressing marsh losses), was several thousand acres in size, employed active marsh management to achieve the project purpose(s), and encompassed multiple marsh types.

The historic permit data base was uninformative about the success any permitted project achieved relative to stipulated project purpose(s). Compliance with permit conditions requiring monitoring and report submittals was

poor. Thus, the effectiveness of management to address marsh losses (that occurred 10, 20 or even 30 years ago for a variety of reasons over the years) and/or affect the habitat of overwintering waterfowl numbers is still to be answered.

4.8.4. Trends Noted From the Previously Issued Permits

4.8.4.1. Relative to Marsh Loss

Coastwide, marsh restoration has consistently been stipulated by the permittee as the singular or a principal reason for management. The acres permitted for marsh restoration as a stipulated purpose have continued to rise more rapidly over the last five to seven years than any other purpose, individually or collectively. However, the clarity of this trend progressively diminishes when viewed at regional and hydrological basin scales. All three principal purposes for wanting to undertake management span the spectrum of marsh types and are evident at all geographic scales. Additionally, but for a very few very large projects with marsh restoration as a stipulated purpose in one basin within each region, stipulated purpose and targeted marsh type do not appear to be strongly linked with each other.

There is an apparent trend between project purpose(s) and historic land loss rates. More often than not a project site encompassed marsh that had undergone loss. However, the loss was not always recent.

As for the effects of historic permits relative to achieving the stipulated purpose for which the permit was issued, the data base is a poor source of information. Monitoring of marsh system attributes in a manner agreed to by permittees (to include submittal of reports) was a stipulated condition of approximately two-thirds of the permits. However, voluntary compliance with monitoring conditions by permittees, with but a very few notable exceptions, has been virtually nonexistent. Whatsmore, a disconcerting number of permittees have not kept NOD advised of address/telephone number changes, thereby hampering NOD's ability to maintain contact or perform follow-ups.

4.8.4.2. Relative to Waterfowl

In Delta Basins 1, 2, 4, 5, and 7 the permits that have been issued and are presumed implemented for waterfowl only that encompass only fresh and/or intermediate marsh encompass 0, 0, 5,385, 6,644 and 640 acres, respectively. Brackish marsh becomes an included marsh type for waterfowl purposes when linked with marsh restoration. Of the Delta Basins, only in

Basin 5 do the permits that have been issued and presumed implemented for waterfowl/marsh restoration include fresh and/or intermediate marsh (8,286 acres) more so than projects that include the brackish marsh type (7,222 acres). In all the other Delta Basins nearly all such permits typically include at least brackish marsh and in some cases saline marsh (Basin 1 - 37,490 acres, Basin 2- 13,572 acres, Basin 4- 78,536 acres, Basin 7- 13,110 acres), suggesting that the focus of waterfowl management in the Delta Region (except for Basin 5) has heavily involved the brackish marsh type (142,708 cumulative acres). Regardless of marsh type, in the Delta Basins waterfowl has been a stipulated purpose for permitted management efforts that encompass 194,928 acres (55 %) of the 353,760 acres permitted (Tables y and z).

In Chenier Basins 8 and 9 the permits that have been issued and are presumed implemented for waterfowl only that encompass only fresh and/or intermediate marsh encompass 679 and 7,388 acres, respectively. When brackish marsh is included for waterfowl only management efforts, the acreages are 2,098 acres and 8,223 acres, respectively. Permits that have been issued and presumed implemented for waterfowl/marsh restoration that include only fresh and/or intermediate marsh equate to 7,040 acres in Basin 8 and 7,948 acres in Basin 9. But for projects that include only the fresh, intermediate and/or brackish marsh types the encompassed acreage increases to 15,219 acres in Basin 8 and to 9,798 acres in Basin 9, suggesting that inclusion of the brackish marsh type was appreciably greater in Basin 8 than in Basin 9. Regardless of marsh type, in the Chenier Basins waterfowl has been a stipulated purpose for permitted management efforts that encompass 53,197 acres (39 %) of the 138,511 acres permitted (Tables y and z).

Coastwide only 14,736 acres of fresh and/or intermediate marsh have been permitted and are presumed to be under management only for waterfowl purposes. The inclusion of the brackish marsh type to waterfowl only management efforts elevates the include acreage to 77,455 acres (16 %) of the 492,271 acres permitted.

Coastwide only 31,674 acres of fresh and/or intermediate marsh have been permitted and are presumed to be under management for waterfowl/marsh restoration purposes. The inclusion of the brackish marsh type to these projects elevates the include acreage to 128,700 acres (26 %) of the total 492,271 acres permitted. Regardless of marsh type coastwide waterfowl as a single or concurrent reason for management encompassed 241,932 acres (50 %) of the 492,271 acres permitted.

Considering that marsh restoration as a single or concurrent reason to undertake management encompasses 407,723 acres (83 %) of the 492,271 acres permitted, waterfowl must be considered a secondary reason to manage but a reason that becomes of added importance when the brackish marsh type is included in areas to be managed.

4.8.4.3. Caution

This analysis of NOD's marsh management permit data base should be regarded as a synopsis of essentially limited, archived information. The existing permit data base should be regarded as a poor platform from which to attempt to draw precise causal inferences about why management has been undertaken in the past or the success/effect of the permitted management efforts relative to marsh type(s), stipulated purpose, or basin. However, with due caution, we conclude that the data base does have utility as a reflection of coastwide and regional trends in management.

4.8.5. Implications to Future Federal Permit Requests

Given the momentum of CWPPRA, NOD expects marsh management and hydrologic restoration plans, featuring measures anticipated to slow, stop or reverse the loss rate of native marsh soils and plants, to be the most frequently stated reason for wanting to perform marsh management that will come under review for Federal permits. This programmatic EIS reflects that expectation.

4.8.6. Measuring Management Success

Marsh scientists and managers heretofore have had the luxury of commenting on the potentialities and shortfalls of someone else's proposed marsh management effort. Now, as prominent participants in CWPPRA planning process, government and private managers and scientists are being held socially, financially, and scientifically accountable for their decisions to implement some and not other plans despite their inability to provide unequivocal answers to cogent questions. Thus, determining the potential for success of publicly funded management efforts has emerged as a prominent concern under CWPPRA.

The potential for success of any future management efforts will be judged in part against the successes and failures of the past. Monitoring has played a role in that capacity in the past but will play a much more prominent role in the foreseeable future under CWPPRA.

Formerly, measures of successful management were typically scaled to waterfowl, fur and alligator harvests, reflecting

the traditional emphasis of management and the notion of the relationship between management, selected marsh dependent animals and marsh vegetation. Although these attributes were seldom measured directly, common indexes included how salinity, water clarity, abundance of emergent and submerged aquatic vegetation and/or water levels differed before and after management began. The assumption was that if these controlling variables responded favorably then the dependent animal and plant species would respond correspondingly. Success was very frequently expressed as the considered opinion of the manager relative to his professional impression of the relationship between the index attributes and harvests. Data sets or other forms of objective documentation are rare. Thus, the debate about what the various forms of hydrologic management can or can't be expected to accomplish and what the corresponding impacts and effects are in any given situation continues (Cowan, Turner and Cahoon 1986, 1987; Turner and Gosselink 1988; Nyman, Chabreck and Kinler 1993; Cahoon 1990 b,c; Cahoon and Groat 1990; Cahoon 1990b). And, Louisiana's coastal marshes continue to erode (Dunbar, Britsch and Kemp 1992).

Commensurate with today's emerging emphasis on combatting marsh erosion, success now more than ever before focuses on the response of the marsh landscape to management. For example, the effect management has on the marsh/open water ratio, or the marsh surface elevation/water level relationship, are often tracked (NOD, DNR, CWPPRA). Both measures reflect the greater emphasis on the health and dynamics of managed marshes.

The concept of successful management is becoming progressively less often infused with professional intuition (de la Cruz 1976b). It is becoming more data intensive and oriented to documenting and understanding the changes in biological processes induced by management rather than simply attempting to record the biological outcome of management efforts.

Monitoring of some physico-chemical attributes is a typical condition included in Federal and/or state permits. That will likely continue to be the case, although CWPPRA projects provide for significantly more pertinent and definitive monitoring than has typically been included as conditions to Federal or state permits.

The focus of monitoring that has occurred has been and will continue to be multi-dimensional (Simmering, Woodard and Clark 1989; Cameron Creole, etc.), and in some cases is specifically inclusive of fisheries (Pittman and Piehler 1989; Paille and Schuck 1993), vegetation (Sweeney, et. al. 1990; Flynn and Mendelssohn, 1991), and short-term water

budgets (Day and Conner 1990) and sediment and nutrient fluxes (Boumans and Day 1990). CWPPRA monitoring is capable of addressing many if not all of these attributes.

Monitoring continues to focus on documenting the effects of management on biological resources and processes. No monitoring of the social and economic effects of management has occurred pursuant to either the Federal or state permit programs. CWPPRA does not provide for monitoring the social and economic effects of projects either.

### 4.9. **Significant Resources and Management**

Louisiana's coastal marshes and their dependent resources are the product of a fascinating and extremely complicated interrelationship between the physical, chemical, meteorological, geological and socioeconomic factors.

Significant resources are the attributes of Louisiana's coastal marshes that are involved with, may be or are affected by management. What follows is a narrative profile of each significant attribute.

The narrative profile of each significant resource is intended to be insightful and was written so that the reader can understand why the resource is considered significant, what controls or influences it, and how it relates to management of Louisiana's coastal marshes.

Citations were included in the narratives to provide foundation. Citations from Louisiana were used when and where appropriate. However, for many biological attributes, particular emphasis is given to a publication edited by DeVoe and Baughman (1986). That publication comparatively profiles, through designed field studies, the biological community components of managed and unmanaged tidal marshes in coastal South Carolina. The physico-chemical setting in South Carolina is not identical. And, the management structures and operational schedules are not identical either. Nonetheless, because there is apparently no correspondingly comprehensive treatment of management of Louisiana's coastal marshes, this comparative approach is useful for a programmatic treatment.

Table 4-1: Comparison of Management Alternatives appears at the end of this section of the PHMEIS. That table takes an ecosystem approach in presenting the relationships between significant resources and their influential factors, alternative management approaches (marsh management and hydrologic restoration), associated assumptions and a statement reflecting the support/insight from the literature.

### 4.9.1. Marsh Soils

Regardless of whether they are organic or mineral, eroded or not, marsh soils are important because they are the medium within which organisms exist, chemical reactions occur and plants anchor themselves and derive life requisite resources.

Historically, management has focused more on what can be made to grow on managed marsh and soils in support of other interests. More recently, the perspective has broadened to include retention of marsh soils. Theoretical (e.g., Dean 1978; Hanson, Kraus and Nakashima 1989; McBride 1989) and applied management (e.g., Seidensticker and Nailon 1987) are resulting in reduced shoreline erosion rates from vegetative plantings and wave barriers. Existing methods have theoretical appeal at arresting marsh losses through water level stabilization but Nyman (1993e) has proposed a loss mechanism suggesting that water levels stabilized near or below the root zone (5 to 6 inches below marsh level) could undermine the emergent vegetation along the marsh water interface.

#### 4.9.1.1. Surface Elevation/Water Depth

Where water is relative to the marsh soil surface is ever changing. Even if the surface elevation of a Louisiana delta or chenier marsh soil never changed, the elevation of the marsh soil surface relative to the water surface is never stable. The relationship between soil elevation and water level is extremely important to marsh plants (McKee and Patrick 1988; Mendelssohn and McKee 1987,1988; Burdick 1989). The relationship is so basic that the distribution of Louisiana's marsh plants has been characterized, and can be fairly well predicted, knowing the range of water levels and the soil surface elevation (Sasser 1977) and something about a single water quality attribute, salinity (Latham, Pearlstein and Kitchens 1991). Marsh soil chemistry, marsh plant communities and marsh dependent animal species reflect and respond to the frequency and amplitude of oscillations.

In some freshwater marshes, water is nearly always at or above the marsh soil surface. In tidal marshes, whether or not they are influenced by salt water, water levels naturally oscillate. Water levels can oscillate above the soil surface (more often in fresh marshes), or from above to below the soil surface. Naturally occurring multi-day events, when marsh substrates are temporarily exposed to the atmosphere, are more prevalent in winter or early spring with the passage of weather fronts.

The depth to which water levels naturally or are induced to

descend into the marsh soil profile pretty much determines the width of the marsh soil profile within which marsh plants can send their roots to anchor themselves and still acquire nutrients in an oxygenated environment. Deeper than that, or to survive in a constantly flooded soil condition, marsh plant root systems must be able to acquire nutrients from the soil and water through means that can operate with little or no oxygen (Kozlowski 1984). Only a few of Louisiana's coastal marsh plants can sustain themselves for very long in soils that remain flooded for more than a week or two, especially when there is little or no oxygen (Gleason and Zieman 1981; Mendelssohn, McKee and Patrick 1981).

4.9.1.2. Persistence

Naturally occurring events that cause water to recede to levels that expose the upper-most soil surface to the atmosphere enough to dry the extreme upper layers help retain organic material transported to and/or produced locally, as well as mineral sediment transported to and/or reworked from elsewhere within the marsh. Such occurrences are part of the natural accretion process that may offset the erosional processes that affect marsh soils Cahoon 1990).

Managers of marshes are aware that losing the surface layers of marsh soils, without a corresponding decrease in water level, diminishes the suitability of the soil to function as a substrate for emergent plant growth due to the consequent effects of "waterlogging" on the physio-chemical attributes of the marsh soil. Management related water level reductions are also purported to maintain soil surface elevations by avoiding the effects of waterlogging and accentuating the capture of the greater amounts of organic matter produced by invigorating plant growth to maintain.

Several authors have suggested that root growth dynamics explain some of the difference between soil surface elevations and sea level. As roots grow the area they occupy expands. Part of the root mass expansion involves roots that grow into newly accreted sediments, thereby immobilizing them and elevating the surface of the marsh, presumably in some proportion relative to sea level. This explanation is seemingly contingent upon plants undergoing root zone expansion at a time that coincidentally corresponds to sediment depositions (e.g., spring flooding) on some predictable schedule, or that the plants are capable of responding fairly rapidly to physico-chemical changes in the soil profile induced when some unknown amount of mineral and/or organic material is deposited on the marsh surface and retained in place long enough for the roots mass to

respond.

Management that diminishes sediment delivery to the marsh surface at the time when root zone expansion is on-going could be counterproductive to an unknown degree to efforts to slow, stop or reverse marsh loss (Cahoon 1991). However, intentional water level reductions are commonly recognized as a way to immobilize sediments, often as a desired consequence relative to other significant attributes (e.g., submerged aquatic vegetation) and management purposes.

The passage of weather fronts during the late fall, winter and spring have been shown to be periods of great sediment mobility (Baumann et al 1984) but emergent plant growth rates during winter and very early spring are minimal or nonexistent. Thus, if late-fall to early spring sediment movements are involved with marsh surface elevations dynamics (an assumption), their retention or loss could be mediated by another or perhaps several other mechanisms, suggesting perhaps differentially operative mechanisms depending upon season (another assumption).

Hurricanes (Rejmanek et al 1988, Meeder 1987, Baumann et al 1984) and storms are also capable of delivering large volumes of sediments to the marsh surface, that may or may not be immediately retained to any appreciable degree. The repository for at least some of those sediments appears to be marsh ponds. Theoretically, some proportion of those sediments may be reintroduced to the marsh surface during tidal movements driven by more moderate weather events. Sediment retention could be facilitated when the marsh surface is naturally exposed to the drying effects of the atmosphere for up to several days after frontal passage, creating a thin veneer of sediments into which roots can expand. Management that suppresses tidal movements capable of remobilizing sediments could adversely affect marsh surface/water level dynamics (Childers and Day 1990a, Cahoon 1991).

If there are indeed seasonal mechanisms at work affecting the marsh surface water level relationship, then marsh plants that can produce roots that originate just above the soil line and extend into the soil during the growing season would in effect create a "root net" that could capture sediments delivered to the marsh surface during the normally occurring higher late-spring through early fall-tides. Nyman at the EPA's workshop on structural marsh management (1994) commented on such a possibility.

Enhancing root zone expansion through water level control/planned reductions has the potential to offset, to some unknown degree, marsh surface elevation reduction

relative to sea level and/or subsidence over what could be expected to occur without management. So, too, might Nyman's observations about the production of aboveground roots. But, both are also tied to when and in what amounts sediments are delivered to the marsh surface. Management actions that suppress the delivery of sediments to targeted marshes (including flow-through designs) and/or suppress water level fluctuations within targeted marshes to the point that sediments are delivered to the marsh surface in greatly reduced amounts, or their delivery mechanism is temporarily eliminated on some regular basis have been characterized as potentially counter productive to management efforts undertaken to slow, stop or reverse marsh losses (Cahoon 1994, Cahoon and Day 1991, Childers and Day 1990a, Dingler 1993).

#### 4.9.1.3. Composition

Native marsh soils are preferred. However, a marsh soil that supports emergent vegetation, even if the ability of the soil to sustain emergent plant growth is artificially sustained, is better than no soil.

### 4.9.2. Emergent Vegetation on Native, Uneroded Soils

Emergent marsh vegetation growing on uneroded, native soils converts inorganic carbon and nutrients into organic compounds and materials, dissipates wave energies, contributes plant biomass to the marsh environment, is involved in marsh nutrient and energy flows, facilitates sediment deposition/ retention, serves as food for some marsh dependent species, provides shelter for some transient as well as resident aquatic organisms, mediates physico-chemical water conditions, and serves as the physical framework upon and within which an associated community occurs.

Depending upon the species targeted for management, flooding either too often or too infrequently can be stressful/lethal. Leaves, and sometimes stems, and for a few species the roots, serve as the surfaces for the exchange of atmospheric gasses. The leaves and stems intercept sunlight. The atmospheric gasses and sunlight are essential to plant growth (Kozlowski 1984).

Again depending upon the targeted species, too much salinity can be stressful/lethal. Accordingly, managers must attempt to maintain water depths and salinity levels, in and over an uneroded marsh soil, below levels that if exceeded would not support the sustained, vigorous growth and reproduction of the desired emergent marsh grasses.

Not all marsh plants grow on all marsh soils. For example, a very common emergent plant species of brackish marshes, which is also the single most important emergent plant species of saline marshes (oyster grass, Spartina alterniflora), can only grow on marsh soils that have more than a minimum amount of mineral material (Pezeshki et al 1989).

Managers of marshes are interested in how specific emergent plant species respond to adjustments of the frequency and amplitude of water level oscillations. As discussed earlier, by reducing water elevations within the soil profile to several inches below the surface from early spring to as late as early summer, some emergent marsh plants produce more above and below ground plant material, and some emergent marsh plant species are favored over others. Elimination of constraining growth conditions (relief of stress associated with flooded soils, higher oxygen levels deeper into the soil profile) are cited as reasons for the invigorated growth response.

Managers interested in attempting to slow, stop or reverse marsh losses may well strive to create conditions that foster the increased production of organic matter by the emergent plant species, as well as the retention and accumulation of organic as well as mineral sediments within the managed area. Accordingly, managers must attempt to maintain water depths, salinity levels, and water movement patterns and velocities, in and over an uneroded marsh soil, below levels that if exceeded would not support the sustained, vigorous growth and reproduction of the desired emergent marsh grasses and/or retention of available sediments.

To achieve these multiple goals, managers can resort to attempting periodic, repetitive reductions of water levels within the marsh soil profile/exposure of uneroded marsh substrates of emulating some natural hydrology is deemed an unsuitable endeavor. The intended result is to invigorate plant growth, stimulating root growth and providing sites for plant colonization.

Increasing the amount and extent of emergent vegetation on native marsh soils has been and apparently will become an even more prominently sought after response to management efforts that depends upon influencing/controlling water levels, sediment/turbidity levels, surface water flow patterns and exchange rates, water chemistry, and the water budgets of marsh soils. The effects of such actions include influences on the microbial and phytoplankton community components, with corresponding effects on nutrient and energy dynamics and the structure and composition of marsh

soils. Because manipulations of water regimes diminish or occasionally seasonably eliminate communications between and often occur out of phase with the natural tidal dynamics, differences between managed and unmanged areas are often observable. As management related differences are largely site specifically induced, the magnitude of any such differences should be fairly well approximated by the total area managed. However, the larger-scale ecological implications are more easily characterized conceptually than quantitatively.

Management has been able to modify conditions in some cases enough to allow the growth and expansion of emergent species. And, management has be shown to be capable of invigorating this significant resource. But the record is inconclusive when is comes to answering the question to what degree can management be counted on to predictably slow, stop or reverse marsh losses.

Marsh losses have been shown to be the result of more than just salt water intrusion, erosion due to tidal action or waterlogging. Within any single tidal marsh type, waterlogging, either natural (Reed and Cahoon 1992) or unintended but due to attempts to address other management interests, would seem to be a more immediate problem more often than salinity variations when it comes to efforts to slow, stop or reverse erosional tends. But, it would be a mistake to ignore salinity, especially if the average and long-term trend is increasing relative to the tolerances of the native plant species or the plant species that would result from management, or the managed areas encompasses more than one marsh type. In such cases, management, such as hydrologic restoration, that strives to maintain ambient salinity differences across the included marsh types but within tolerances would seem to have a greater potential to perpetuate the include marsh types.

4.9.3. Emergent Vegetation on Eroded But Exposable Soils

Emergent marsh vegetation induced to grow on eroded but exposable soils converts inorganic carbon and nutrients into organic compounds and materials, dissipates wave energies, contributes plant biomass to the marsh environment, is involved in marsh nutrient and energy flows, facilitates sediment deposition/retention, serves as food for some marsh dependent species, provides shelter for some transient as well as resident aquatic organisms, contributes to mediating physico-chemical water conditions, and serves as the physical framework upon and within which an associated community occurs.

Managers may attempt reductions of water levels to expose

eroded marsh substrates to invigorate plant growth, stimulating root growth and to provide sites for plant colonization. Such water level reductions may be attempted as frequently as once each year for several successive years or as infrequently as once in every three to five years.

Depending upon the species, flooding either too soon after germination/growth begins or too deeply can be stressful/lethal. Accordingly, managers must consider maintaining water depths, in and over an eroded marsh soil, for a period that will induce and support the hopefully vigorous growth and possible reproduction of emergent marsh grasses.

The emergent plant species that are induced to grow on exposable, eroded soils can be different from those growing on the uneroded marsh soils. Annuals typically occur on the exposed, eroded soils. When and how long eroded soils are exposed can influence the composition of the plants induced to grow.

This response to management is more likely to arise as communications between managed and unmanged areas are reduced. Efforts to revegetate exposable, eroded marsh surfaces have occurred in the past and are likely to continue into the future but more as an effort to slow, stop or reverse the conversion, through erosion, of marsh soils to open water. Because this effort requires invoking the tightest controls on the hydrology of the managed area, the consequences and ecological implications are probably similar to in form but more intensive than those that occurs when attempts are made to stimulate/invigorate aquatic vegetation within managed areas.

This significant resource can only be expressed in semi-impoundments where marsh management or, in rare cases, in areas subjected to hydrologic restoration that involves water levels reductions. As such, vegetation induced to grow on exposable soils would have a very high probability of reducing erosion of any remaining vegetation on native soils. However, in a situation where the targeted ares is devoid of native vegetation, this aspect of management could be the only way to reestablish a presence of emergent vegetation. In either case this is an intensive management effort with the greatest potential to impact most of the other significant resources, some beneficially and others adversely.

4.9.4. Marsh Ponds/Open Water Areas

The concept of marsh includes shallow open water areas. Pond areas are natural, historic features of many marshes.

Relative to the marsh losses that have occurred since the mid-1930, this significant resources is expanding.

Marshes that include shallow open water areas exhibit a greater number of dependent species. That is especially true relative to fishery resources.

The ideal ratio of marsh area to pond area is unknown. However, a commonly referred to range with implications to waterfowl management interests is between 50 and 90 percent.

4.9.4.1. Size

The margins of smaller ponds are less subject to the effects of wind-induced waves. Therefore, wave-induced shoreline erosion and events of elevated turbidity levels may occur less often and/or persist for briefer periods. Smaller ponds may be more appealing to recreationalists.

Water level control, more particularly periodic water level reduction, temporarily draws the water edge away from the vegetated pond margin. The potential for wave-induced erosion of the pond margin is somewhat reduced but such an action affects some significant resources beneficially and other adversely.

4.9.4.2. Depth

Marsh ponds range in depth from just a few inches to several feet deep. By lowering water levels, pond depths can be reduced. Shallower ponds are not as susceptible to wave action. Reduced wave action may reduce but probably does not eliminate turbidity. Clearer water favors the growth of submerged aquatic vegetation (Joanen and Glasgow 1965). Pond depths of 18 inches or less are conducive to the growth of submerged aquatic vegetation (which also contributes to reducing turbidity through wave attenuation) and are attractive to waterfowl. Retaining some water in ponds facilitates movements of watercraft (Chabreck and Nyman 1989). Manipulating pond depths affects some significant resources beneficially and others adversely.

4.9.4.3. Interspersion

Marshes with some, preferably small ponds, are more desirable than expanses of solid (also called unbroken) marsh from the standpoint of habitat and species diversity. The increased desirability relates to the vegetation:pond/open water ratio. Ratios greater than 50 % but less that about 90 % have more associated animals than marshes with no open water/pond features.

4.9.4.4. Persistence

Smaller ponds are presumed to be less susceptible to wave-induced pond edge erosion potential. Shallower ponds are not as susceptible to wave action. Reduced wave action reduces shoreline erosion potential of ponds. Thus, marshes with multiple smaller ponds may be preferred by managers over a marsh with a few large ponds for wildlife and fisheries purposes.

4.9.5. Aquatic Vegetation

Floating and submerged aquatic vegetation convert inorganic carbon and nutrients into organic compounds and materials, dissipate wave energies, contribute plant biomass to the marsh environment, are involved in marsh nutrient and energy flows, facilitate sediment deposition/retention, serve as food for some marsh dependent species (Chabreck et al 1985), provide shelter for some transient as well as resident aquatic organisms, mediate physico-chemical water conditions, and serve as the physical framework upon and within which an associated community occurs.

The plants species managers are concerned with grow only in shallow water and are excellent waterfowl food. In marshes influenced by salinity, widgeon grass (Ruppia maritima) is the single most important submerged aquatic species in ponds. With the water component of Louisiana's coastal marshes continuing to increase, shallow open water areas are not limiting or expected to become so.

These plants are adapted to exchanging gasses with their leaves, stems and roots completely submerged or positioned just below the waters surface even when the water is murky and little sunlight is available to drive photosynthesis (Kozlowski 1984). Other plants in this group are adapted to exchanging gasses and photosynthesizing in leaves and stems that float on or extend above the water surface.

These plant groups are dependent upon somewhat stable water levels. Exposure of these plants to the atmosphere and cooler temperatures during the fall and winter months due to naturally occurring water level changes often prove lethal.

Stable water levels, firm soils, low turbidity levels and salinity levels that don't exceed 15 to 18 parts per thousand are ideal (Joanen and Glasgow 1965).

Managers of marshes undertake efforts to reduce salinity, turbidity and/or water level fluctuations to levels that are not stressful or lethal. If successful, conditions arise that are conducive to the expansion/invigorated growth of

submerged aquatics (Chabreck 1994). Management options include excluding or reducing the amount of higher salinity water from the managed area (salinity thresholds), and periodically reducing water levels to consolidate sediments to reduce turbidity. Elevated water temperatures can suppress growth and physiological function. Introducing cooler water, from rainfall or from areas outside the managed area, is a corrective action. However, the source of the cooler water may be the unmanged estuary where ambient seasonal salinities exceed the salinity threshold established for the managed area.

Increasing the amount and extent of aquatic vegetation has traditionally been undertaken to improve the condition of marshes for overwintering waterfowl. Given the general success of that effort, that endeavor is expected to continue to be a desired response to management efforts that depend upon controlling water levels, sediments, flow patterns, water chemistry, sediment dynamics and the structure, composition and chemistry of marsh soils. Unintended effects include influences on the microbial and phytoplankton community components, with corresponding effects on nutrient and energy dynamics. Because water management regimes are often very similar between managed areas, management's effects on nutrient dynamics should be a function of the total area involved in management, sources of microbial communities and how the chemistry of the involved soils and the phytoplankton and microbial community components respond to management.

### 4.9.6. Soils of Marsh Ponds

Soils of marsh ponds are usually targeted for management to induce changes beneficial to targeted wildlife species. The intent is to stabilize substrates to encourage the growth of submerged aquatics. Recent work by several investigators suggests consolidating pond substrates on a regular, short frequency, repetitive basis could have implications to the sediment dynamics of some marshes.

#### 4.9.6.1. Surface elevation

Manipulating water depths over and within these soil profiles is undertaken to create soil growth conditions conducive to inducing/invigorating the growth of submerged aquatic vegetation (Loanen and Glasgow 1965) and possibly inducing the growth of emergent marsh grasses, especially along ponds edges, thus contributing to slowing, stopping or reversing the erosion of marshes.

4.9.6.2. Water Depth

Seasonally adjusting, including in some cases planned, periodic reductions of marsh pond soil profile water levels, or simply diminishing the variation in depth of water in ponds, is undertaken for several reasons. They are to slow, halt or reverse the loss of pond soils through wave and tidal action, and improvement of growing conditions for rooted submerged aquatic vegetation.

Some significant resources are benefitted, others may show no relationship to this management action while other significant resources may be adversely impacted.

4.9.6.3. Persistence

Seasonally adjusting, including in some cases planned, periodic reductions of marsh pond soil profile water levels, or simply diminishing the variation in depth of water in ponds, contributes to slowing or halting losses of pond soils, and perpetuates the retention by ponds of mobilized marsh soils, thereby, aiding in slowing marsh erosion.

4.9.6.4. Composition/Consistency

Soils that consist of unconsolidated organic matter are subject to erosion and are not conducive to the growth of submerged aquatic vegetation.

4.9.7. Fish

Fish are specific kinds of organisms. But, a popular usage of the term fish, and the one as used in this EIS, encompasses a wider variety of actively swimming aquatic life forms.

Ecologically, fish can affect nutrient and energy dynamics. There sheer numbers can influence the species structure of the benthos. Fish are a reservoir of nutrients and energy. Fish also redistribute nutrients and energy within the marsh as well as between marsh types, adjoining aquatic environments and to terrestrial settings as fertilizer. Many fish are recreationally and commercially important, and as such have social, economic and cultural importance directly to man.

There are several ways to profile this extremely diverse collection organism. One is to focus on where they are in the water column, what they eat and whether they exhibit migratory movements linked to reproduction.

One group tends to inhabit tidal pools, grassbeds and the

marsh surface and edge, eat small animals from the plankton and benthic communities, and reside in the marsh all year long. Killifishes (e.g. Fundulus spp.) and silversides (e.g., Menedia spp.) are examples.

A second group tends to swim in schools and throughout the water column and undertake migrations. Two feeding strategies are prominent. Menhaden (Brevoortia sp.) is a good example of the group that preys on planktonic forms and inhabits the nearshore open waters of the Gulf as adults but as juveniles enter and use the marsh as a nursery area. The feeding strategy of the second group is to prey upon other fish, including other members of it own group, and roam the open ocean throughout their life.

The third group is the bottom fish. Members of this group forage near or along the pond or open water bottoms in marshes or shorelines or other water bottoms. Many are generalists, opportunistically ranging for food that may consist of benthic worms, small fish and scavenging. Others, like the flounders (e.g., Paralichtys sp.) may seek food or bury in the mud awaiting food in the form of shrimp, small crabs, worms, and other fish to pass by. Still others (mullet, Mugli spp.; gizzard shad, Dorosoma) appear to range widely, in loose schools, even though they may actively consume detritus in large amounts for food. Other loosely schooling coastal marsh residents (e.g. the sea trouts, Cynoscion spp.; red drum, Sciaenous sp.) actively seek and prey upon shrimp and other fish like menhaden. Reproductive movement patterns of this group, like shrimp, involve a movement by nearly mature or fully mature individuals from the marsh to nearshore Gulf waters where breeding occurs. Juvenile forms, often planktonic in size, begin to appear in the bays, shallow waters and marshes of the coast as early as late winter and continue through spring. Once there, maturation continues. Some species return to the nearshore Gulf waters the following fall before reaching full maturity. Others linger longer, returning to the Gulf only as breeding adults.

Reproductive and feeding movements are influenced by different factors at different life stages. Tides and winds strongly influence reproductive movements from the Gulf to the marshes. Once in marsh nursery areas and capable of swimming, species distributions appear to be related to water depth, tidal direction, salinity and turbidity, may be behavoriially mediated, and may also be attributes biologically meaningful to predators. Daily feeding movements appear to be triggered by the direction and movement of the tides, winds and short-term meteorological conditions. Reproductive and migratory movements by more mature forms and adults in the fall appear to be triggered

by water temperature and salinity. These movements suggest an active response to gradients.

Turner (1977) described a positive mathematical relationship between commercial penaeid shrimp harvests and the area of estuarine intertidal vegetation. The area, average depth or volume of estuarine waters did not seem to contribute to the relationship and the role of aquatic vegetation was undetermined. Turner and Rao (1990) concluded that, even with regional variation, canal embankments and marsh losses were directly related. Peterson and Turner (1994) reported that resident and transient species frequented the shallow waters within 10 feet of the marsh edge as well as the marsh surface several feet in from the edge when tides permitted in a relationship that they suggested could be correlated with predator prey relationships. They made no distinction between a stable marsh edge or marsh edge that arises as a result of erosion. However, given the historic losses and the prospect for continued marsh losses, the marsh edge will continue to be a resource that exists in abundance.

Estimates of production of fish in the open estuary and marsh are generally lacking due to the complex life cycles and movement patterns of the component species. Surrogates for productivity are standing crop and catch per unit effort. Perret et al (1993) present brief profiles of the more important commercial species.

Because there is no time during the year when fish are absent from Louisiana's costal marshes, the effects of management on fish have been the source of a great deal of research during the last decade here in Louisiana and elsewhere. The emphasis of that research has been on determining the effects of some kind of water control structures on fisheries and the factors that influence them. That interest emerged in response to academic curiosity and concern about the potential for possible system-wide effects of using certain management practices and structures as well as a desire to know the effects on commercially and recreationally important fishery species.

However, there are really three questions: 1) how do organisms respond to management structures; 2) what is the effect of that response on production within managed areas; and, 3) what, if any, are the effects of management in general.

Paille et al (1989) examined how white shrimp production responded to structures and based upon their data speculated about the validity of a number of hypothesis that attempt to explain how weirs and other control structures reduce recruitment of estuarine organism. They conclude that more

study is required to discern what the relationship is between water control structures, recruitment and production.

Herke (1979, 1971, 1967) compiled evidence that management structures could and did influence the fisheries resources of marshes relative to all three questions. Relying heavily upon designed manipulative studies in a brackish marsh in the Chenier plain, convincing evidence emerged that the composition of the fishery community in a semi-impounded marsh managed with a fixed-crest weir (Herke et at 1992), and in subsequent studies with a fixed-crest weir with a 6-inch vertical slot (Rogers, Herke and Knudsen 1987) underwent measurable changes in fish community composition and exhibited other temporal and size differences as well (Rogers and Herke 1985 a,b). Changes arose within a year because several fishery species, including several commercially important species, encountered reduced opportunities to enter and leave the managed area in response to environmental cues such as frontal passage, and water temperature and salinity changes (Herke, Wengert and LaGory 1987). Other water control structure designs evidenced less dramatic responses but still induced measurable differences (Rogers 1989; Rogers, Herke and Knudsen 1987, 1992). The water control structures were concluded to be a physical as well as a behavioral impedance to some species.

The response of fish communities within managed semi-impoundments is not unique. Perry (1981) and Perry and Joanen (1986) report finding increased shrimp biomass but generally reduced numbers of individuals similar to the response reported by Herke in several of his studies. Similar patterns were observed for decapod crustaceans by Olmi (1986), and fish in general by Wenner et al (1986) in a managed semi-impoundment in South Carolina managed with a flap-gated culvert and variable-crest weir assembly.

Induced differences associated with the vertical-slotted weir were about half the differences associated with the traditional fixed-crest weir (Rogers, Herke and Knudsen 1987). Rogers (1989) reported measurable differences across a rock weir located in a Delta marsh were similar to conditions behind a slotted weir. Studies on some (Rogers,Herke, Knudsen 1992) but not all the kinds and combinations of structures have yet to be performed. However, physicochemical conditions and the composition of the fish community within a Delta marsh managed with fixed-crest weirs and a variable-crest weir fitted with a flap-gated culvert also diverged measurably from the prevailing condition in the surrounding unmanaged portions of the marsh (Simmering, Woodard and Clark 1989; Rogers and Rogers 1990).

Based upon Louisiana studies, long-term data collected from several other managed Louisiana chenier marshes (Konikoff and Hoese 1989, Hoese and Konikoff 1990), as well as studies of managed South Carolina (Olmi 1986, Wenner 1986, Wenner et. al. 1986) and a New England salt marsh (Sinicrope et al 1990), many different kinds of structures used for management in different parts of the country must be presumed to affect the movements of a wide variety of commercial and noncommercial fishery species within as well as between some kinds of managed and unmanged marshes.

As for the effects of management on fish production, management that uses structures, semi-impoundments, and/or causes water levels to recede from the marsh edge for longer or prolonged periods would apparently disrupt the temporal and spatial relationships fish exhibited relative to nearby shallow water and the marsh edge as reported by Peterson and Turner (1994). The net effect would be a reduction of habitat diversity and accessibility, especially for resident species that apparently are capable of using the water over the marsh surface for life functions (Rakocinski et al 1992). Relative to managed areas, apparently this translates into a greater biomass of some species (e.g., shrimp) contributed by fewer numbers at the expense of unimpeded access of many other species that contribute to overall production.

Hoese and Konikoff (Hoese and Konikoff 1990 a,b), and in association with others (Hoese et al 1990), have also been recently active Louisiana investigators interested in the fish communities in managed and unmanaged areas. Hoese and Konikoff (1995, galley proof) scrutinized existing fishery data sets and hypothesized that differences in fish communities induced by management and structures could be eliminated once water levels compromise the hydrologic integrity of the managed area thereby reintroducing species from the surrounding marshes. If their hypothesis proves to be valid, induced physico-chemical differences, regardless of their magnitude, would also be erased and a semi-impounded marsh could exhibit a cycle of repetitive biological and physico-chemical divergences erased on an unknown frequency by tidal inundations.

The overall effects of management remain to determined. All of the studies to date can only be used to infer what the response might be to hydrologic restoration projects. However, any management project that does not consist of semi-impoundment and/or involve water level controls that eliminate tidal waters from flowing over the marsh surface and/or water level reductions that results in withdrawing the water's edge from the marsh edge would probably have

less adverse impacts to fisheries resources. Additionally, any fishery species that is confined to a managed areas and cannot complete its entire life cycle within the managed area will be unavoidably impacted adversely. In this regard, perhaps Montague, Zale and Percival (1987, page 751) captured the essence of the relationship between managed marshes and fishery resources:

> "*Estuarine organisms that benefit most from the perhaps equal or greater nutrition present in managed impounded marshes are those that can enter the impoundment and survive there while feeding. The most significant question concerning the effect of impoundment on production of estuarine fish and shellfish is not whether the net transport of bulk organic matter and plant nutrients is altered, but rather whether estuarine fish and shellfish can enter, grow, and leave impounded marshes in a way that is compatible with estuarine fish management objectives.*"

Expansion of management programs that incorporate the more rigorous water level management alternatives would be expected to be proportionally impact intensive site specifically and cumulatively.

4.9.8. Wildlife

To achieve other goals or intentions related to wildlife, a manager quite frequently must first improve the condition of the habitat: 1) to produce a more and/or better quality furs; 2) produce more and/or larger alligators; or 3) to be more attractive to waterfowl than many other areas they could potentially use in the general area.

Efforts to improve habitat conditions for selected species within this marsh-dependent animal group was once the single most important reason to conduct management. The reason was driven by the socioeconomics of the targeted species. For the same reason, but balanced against other interests, targeting wildlife still remains an important reason to undertake management.

Ecologically, wildlife are involved with and can affect nutrient and energy dynamics. Their numbers, size, mobility and dietary requirements can influence the structure of any marsh. Some, such as the native muskrat (Ondontra zibethicus), American alligator (Alligator mississipiensis), and some waterfowl species (snow geese - Chen hyperborea), but more particularly the exotic nutria (Myocastor coypus), have exhibitied the biological capacity to temporarily (muskrat) and perhaps permanently (nutria, geese, alligator) convert vegetated marshes into shallow open water areas.

Wildlife consume, store and redistribute nutrients and energy. Depending upon species, that redistribution can be within a marsh (e.g., small mammals), between marsh types (e.g., resident waterfowl), and to other Louisiana marsh and/or terrestrial systems (e.g., deer, wading birds), as well as to terrestrial settings elsewhere in the world (migratory waterfowl). Collectively, several waterfowl and mammalian species and one reptilian species are recreationally and/or commercially important, and as such have social, economic and cultural importance directly to man.

Historically, Sprunt (1967) presented a commentary on how waterfowl and several major bird groups are dependent upon the South Atlantic and Gulf Coast marshes and estuaries. Palmisano (1972) reported on the distribution of several recreationally and commercially important species that served as indices of the relative abundance of the total abundance of birds and mammals. His findings were reported by marsh type and region for furbearers (e.g., muskrat, nutria, mink, raccoon,otter) and several species of waterfowl. Spiller and Chabreck (1975) reported higher use by coots, ducks and non-game birds, especially during the winter, because of more stable water levels in ponds behind fixed-crest weirs in otherwise open marshes.

More recently, Chabreck, Joanen and Paulus (1989) presented a general review of considerations and actions for waterfowl management, which largely reflected the historic record. Turner, Day and Gosselink (1989), relying heavily upon the findings of Spiller (1975) reported that management did not reduce wildlife as part of their summary of how several significant resources of Louisiana's coastal marshes have been reported to respond to management.

4.9.8.1. Reptiles, Amphibians, Birds and Mammals

4.9.8.1.1. Reptiles and Amphibians

The turtles, alligators and snakes are the most prominent reptilian species within Louisiana's coastal marshes. As a group, 33 of the 36 species are expected to commonly occur in fresh and/or intermediate marshes (Brantley, Pers Comm). The diamondback terrapin (Malaclymes terrapin), pygmy rattlesnake (Sisttrurus miliarus) and the saltmarsh water snake (Nerodia clarkii) occur in brackish and saline marsh types. Most are inclined to be found in proximity to surface geomorphologic features that, depending upon species, provide nest sites, food and/or relief or escape sites from flooding (Platt et al, 1989). Turtles either frequently the bayous and shallow waters of the marshes (diamondback terrapin) or are migratory marine forms that

tend to be found mostly in the larger shallow open waters of the coastal bays and bayous or nearshore Gulf waters (see also Threatened and Endangered Species). The association between migratory marine turtles and Louisiana's coastal marshes is usually associated with food acquisition during seasonal migratory movements.

Pursuant to Louisiana's Department of Wildlife and Fisheries laws, alligators are classed as furbearers. Alligators can occur in all marsh types. However, breeding and nesting occur much or often in intermediate and fresh marshes. Young alligators in fresh marsh consume crawfish. Their young counterparts in intermediate and brackish marshes consume blue-claw crabs (Callinectes sappidus). Adults alligators prey heavily on nutria. The higher levels of salinity in brackish and saline marshes are physiologically stressful. The tidal dynamics and topography of more saline marshes are limiting because of the lack of physiologically palatable water for juveniles and nests sites flood.

Of the 12 or so amphibian species likely to occur in Louisiana coastal marshes, approximately seven can occur fresh, intermediate and brackish marsh types. They commonly associate with surface geomorphologic features where food, water, cover and relief from flooding and salinity occur. Salinity is the apparent limiting factor.

In summary, reptiles and amphibians, especially those in managed fresh and intermediate marsh undergoing or under the eminent threat of salt water intrusion, to be unintended but indirect beneficiaries of management efforts and past actions of man.

4.9.8.1.2. Birds

Seasonally migrant and resident bird species are associated with Louisiana's coastal marshes. Wading birds (herons, ibis, spoonbills, storks), shorebirds and passerines (resident-summer/winter and migrants) and waterfowl are four main groups. Appendix I is a synopsis of much of the pertinent literature.

The seasonal prominence of shore and other wading birds usage of managed marshes is well documented. Managed marshes are apparently used preferentially because of the water level differences between managed and unmanged marshes. Managed marshes are used for feeding areas more so than unmanaged areas when water levels in unmanaged areas. Wading birds generally prefer isolated groves of trees or shrubs for roosting and/or breeding and require alternate sites for the same purposes, sometimes referred to as rookeries. The potential for rookeries to be present at any

given project site is acknowledged. Previously issued projects were reviewed and assessed for the presence of rookery sites. Future projects submitted for permit consideration will also be reviewed and assessed for the presence of rookery sights. Therefore, a project by project inventory for the potential for rookery sights to occur near or within each and every candidate project is beyond the scope of this PHMEIS. Summer/fall drawdowns can provide areas where food is concentrated. Collectively, the approximately 15 resident/migratory species that comprise this group exhibit species-specific foraging behaviors over water depths between one and 20 inches.

The approximately 30 species of migratory and wintering shorebird species exhibit species-specific foraging behaviors that encompass wet meadows, exposed mud flats to stable water depths of one to two inches. Management that provides these foraging situations during mid-March through May and again from early July through October can augment natural food levels and increase diversity of shorebird assemblages.

The majority of the approximately 70 passerine species occurring at some time in Louisiana's coastal marshes are opportunistic, associating with vegetation on embankments, cheniers, or exposed mudflats. Thus, management that targets vegetation growing on such elevated areas generally improves conditions for most species of this group, while summer/fall drawdowns (a proactive that is very uncommon in the management of coastal Louisiana marshes) that create weedy upper marshes and flats are attractive to wintering sparrows, pipits meadowlarks, blackbirds, rails and snipe.

In summary, birds, as a group, are perceived to be unintended but indirect beneficiaries of management efforts and some past actions of man.

A narrative of the pertinent literature is presented as Appendix I.

4.9.8.1.3. Mammals

In general, many mammalian species derive some life requisite resources from Louisiana's coastal marsh types. Aquatic mammals (e.g., dolphins, seals and whales) do occur. Only the Atlantic bottle-nosed dolphin (<u>Tursiops truncatus</u>) typically occurs in the larger shallow open water bays adjacent to the Gulf where they forage for fish. All others can be recorded as rare or accidental records of species whose habits are oceanic. Whales are similarly characterized. Species that burrow (e.g., moles) and other insectivorous mammals (e.g., shrews, armadillo - <u>Dasypus</u>

novemcentus) occur rarely in Louisiana's coastal marshes but can venture into the marshes that abut embankments, natural ridges or cheniers with enough elevation to provide refuge from daily tidal flooding. The swamp rabbit (Sylvilagus aquaticus) is similarly limited for nesting. Some insect-eating species (e.g., three or four bat species) regularly travel to the fresher marsh types for insect food but also rely upon nearby terrestrial cover types for other life requisites (e.g., Spanish moss in oaks for roosting). Squirrels are like the bats...they associate with marshes more or less indirectly where trees on ridges and cheniers provide food and shelter. Several species of rats and mice, however, forage on insects, invertebrates (e.g., small crabs) and plants in all four marsh types, but are also probably limited by nest sites and refugia from higher flood waters (Bosenberg 1979). Ridges, embankments and cheniers, especially those vegetated with shrubbery, provide sites to construct elevated nests of vegetation, protection from avian predators and relief from all but the highest of tides. The white-tailed deer (Odocoileus virginianus) has been observed in all four marsh types. Population sizes tend to be greater in the fresher marsh types (attributable to a wider variety of higher quality food items) and where natural ridges and cheniers, man-made embankments occur (birthing sites, refugia from flooding).

Some of the mammals are intended, direct beneficiaries of management. However, others apparently could be unintended but indirect beneficiaries of management and past actions of man. Some aspects of enhancing their habitat conditions adversely affects some significant resource, beneficially affects others and may have little or no affect on others.

4.9.8.2. Furbearers

Furbearers that are linked with Louisiana's coastal marshes include the opossum (Didelphis virginiana), raccoon (Procyon lotor), mink (Mustela vison), stripped skunk (Mephitis), and river otter (Lutra canadensis). These species are wide-ranging opportunistic omnivores (opossum and raccoon) or carnivores. Their relationship with the marsh is similar to most other mammals, venturing into the marsh to prey on other animals for food. Raccoons and opossums are both trapped commercially but recreational hunting is equally or more prominent.

Seldom do management efforts target only furbearers. The two prominent furbearers that are targeted for management are the native muskrat and the introduced nutria.

Nutria and muskrats are the pre-eminent fur bearing species of Louisiana's coastal marshes. The native muskrat occurs

in all four marsh types. The introduced nutria rarely if ever occurs in the brackish or saline marsh types. The nutria is physically larger than (sometimes as large as a small beaver) and behavorially superior to the muskrat. Therefore, the nutria is more prominent in the intermediate and fresh marsh types throughout coastal Louisiana. The two species graze aerial as well as subaerial parts of common emergent marsh plant species, will consume aquatic vegetation as well and will also eat small crustaceans and insects.

Olney's three-corner grass (Scripus olneyi), a co-associate of salt meadow grass (Spartina patens) of intermediate and brackish marshes, is particularly important to muskrats. It is by far the preferred food of muskrats in the brackish marsh type and is also used to construct shelters. Where Olney's three-corner grass becomes disproportionately abundant, often as the result of some management practices, muskrat densities often respond by increasing rapidly, leading to increased grazing and the possible denuding of the marsh (called eat outs). In intermediate and fresh marshes, cattails (Typha sp.) and paille fine (Panicum hemitomon) are heavily used species for food. Diseases, water level fluctuations floods, and food shortages apparently influence population size more so than do trapping or predation.

Nutria were introduced to Louisiana in the 1930's. Despite being trapped heavily for their rich fur since the mid-1940's, they now occur throughout the state's coastal marshes, especially the fresh and intermediate marshes. Like the muskrat, nutria also are prolific breeders. Vegetarians, they eat several pounds of food each day. Thus, when populations rise nutria can induce longer term change in the structure of the marsh. More recent studies suggest the role of nutria in marsh loss may have been underestimated. Alligators and man are their main predators. Populations sizes apparently are reduced by freezing temperatures but freezing temperatures in the coastal marshes are infrequent and unpredictable events. Trapping, or some other population control, may well be necessary to protect marshes.

Management interest in targeting nutria and/or muskrat has declined during the last decade. Changing social perceptions about furs translated into a long-term decline in fur prices. That perception may persist. However, trapping, as a method to control muskrat and nutria numbers, has been cited more recently as possibly necessary for the health of the marsh as nutria are more and more suspected of accentuating marsh losses (Taylor and Grace 1992; Taylor et al 1992; Conner 1992; Foote and Johnson 1992; Linscombe

1993; Llewellyn and Shaffer 1993; Nyman, Chabreck and N. W. Kinler 1993a).

Nutria and muskrat are intended (but seldom specifically targeted) indirect beneficiaries of management. Stabilized water levels during the winter are conducive to marsh burning, which is undertaken to stimulate the growth and/or improve the coverage of a few marsh grass species (especially Olney's three-corner grass) for muskrats and to improve access to marshes. The other furbearing species are apparently unintended but indirect beneficiaries of management and past actions of man.

4.9.8.3. Waterfowl

Collectively, the following citations are a sampling of the literature that speaks eloquently to the linkage between management and waterfowl: Chabreck (1960, 1968, 1976, 1971), Chabreck and Hoffpauer (1962), Carney and Chabreck (1977), Chabreck and Nyman (1989), Chabreck et al (1985), Chabreck et al (1974), Jemison and Chabreck (1962), and Taylor (1978).

According to the permit database, waterfowl is the only class of marsh-dependent species for which management has been singularly initiated. Waterfowl is a collective term including both ducks and geese. The focus of management in coastal marshes has been on ducks.

The mottled duck (<u>Anas fulvigula</u>) is the only year-round resident duck of the Louisiana coastal marshes. It is never a species specifically targeted for management. Population levels exhibit between year differences but the trend suggests a stable population. This duck can be seen in all four marsh types throughout the year but is more likely to be seen in intermediate and fresh marshes at all times of the year. It consumes both marsh plant (aquatics) and animal material (insects are especially important to the young), but rice consumption from nearby upland rice fields in the Chenier plain regions by adults also occurs. Seasonal usage of marsh types may vary related to breeding behavior. Moorman (1991) has shown that salinity of drinking water can affect nesting success. Breeding begins in March and may extend into May. Marsh nesting sites are typically well hidden in dense stands of grass. In marshes influenced by salinity, nests are cited in <u>S. patens</u> on slightly elevated areas but upland ungrazed fields and rice fields also serve as nest sites. Marsh nests are typically elevated above the marsh floor to avoid flooding. Nest flooding can be a serious problem if renesting does not occur. The creation of elevated nesting sites (on or along man-made embankments), the behavioral adaptiveness to nest

in non-marsh sites, prior and current management practices targeting overwintering, migratory waterfowl in general and a flexible diet as young and adults (that includes rice) probably all played a role in this species not exhibiting any appreciable declines given the marsh losses that have occurred.

It is general common knowledge that millions of migrating ducks of several species either overwinter in Louisiana's coastal marshes or temporarily reside in the marshes. Blue-winged teal migrants (A. discors) arrive first (August). While the migrants are here they eat several different species of aquatic vegetation and the associated invertebrates from fresh to brackish marshes before most move on by October. Those that stay may forage in nearby upland rice fields.

The other species that truly overwinter in Louisiana's coastal marshes begin arriving in late September. Arrivals continue until November. Collectively, overwintering species occur in all four marsh types in both physiogeographic regions. Nearly all species selective consume some aquatic vegetation in varying amounts.

Within basins, some duck species prefer different marsh types as well as amounts of open water and vegetated area and water depth of the ponds is also critical. Feeding behavior and water depth are related. Species that typically feed without diving beneath the waters surface are called dabbling ducks. Northern shovelers (A. clypeata), green-winged teal (A. crecca) and blue-winged teal are dabbling ducks. The shoveler and the green-winged teal prefer pond water depths of not much more than four inches. Blue-winged teal prefer ponds water depths of about eights inches or less. Mallards (A. platyrhynchos) eat seeds and plant parts from ponds with water depths as much as 18 inches deep but will also feed in rice fields. Gadwalls (A. strepera) initially eat aquatic vegetation growing in brackish marsh ponds in brackish marshes. Later they begin to consume aquatic vegetation from fresher marsh types. The northern pintail (A. acuta), like the mallard and gadwall, is another larger-bodied dabbling ducks that selectively consumes aquatic vegetation from ponds with water depths about 12 inches deep. Initially it forages in brackish ponds for aquatic vegetation. Later in the year this duck tends to switch to eating the seeds of emergent plant species from the fresh to brackish marsh types. Widgeongrass is the single most widely consumed aquatic plant species.

Management for waterfowl typically attempts to provide marsh to open water ratios that range between 50 and about 75

%percent, ponds with stable water levels and if ponds can be manipulated to contain a luxurious growth of submerged aquatics all the better.

Nearly all of the migratory waterfowl are collectively targeted for management. However, the bulk of the waterfowl management effort targets the dabbling ducks. Water levels reductions that expose substrates contribute to producing more luxuriant growths of submerged aquatics and encourages annual vegetation to grow which is also very attractive to waterfowl as foods. The other waterfowl species are untargeted but intended beneficiaries. What measure of difference in benefits there may be between simply stabilizing water levels versus a marsh with annuals and luxurious growths of submerged aquatics must take into consideration not just the ducks but the socioeconomics as well.

4.9.9. Subsurface Geology

The Pleistocene formation is a stable geologic formation. It is the platform upon which the materials have been deposited from the Mississippi and Atchafalaya Rivers and Gulf processes over the last 70 centuries. How deep that platform is from the soil surface affects how much the overlying soil can naturally settle and compact. Organic soils naturally tend to compact more and faster than mineral soils. Therefore, deep organic soils have a greater capacity to show vertical elevation differences.

Stable though it is, the Pleistocene formation is not flat. It slopes toward the Gulf, in some places more than others. Thus, regardless of the soil type, there is a tendency, in response to gravity, for soils on the Pleistocene platform to slide down the slope of the formation to the Gulf.

Different soil compaction potentials and rates of sliding create differences in the rate at which the land (marsh) surface naturally subsides relative to sea level throughout Louisiana's coastal zone. The result can be visualized as an undulating surface, some spots higher and some spots lower than others. The elevations continuously change, both in terms of absolute elevation and in terms of sea level changes. The higher areas tend to remain higher longer and the lower areas tend to become lower more quickly.

At the coastal scale, the higher spots would tend to occur where the Pleistocene is within 20 to 30 feet of the surface and where the remnants of former, natural river levees and nearby overflow plains exist. At the regional scale, the same patterns can be seen especially where smaller distributaries occurred. At the basin scale, the undulating

pattern becomes even more finer grained. At the project site scale, elevation differences can be observed, or inferred from the vegetation, are seldom measured but referenced relative to planned water level manipulations.

Management cannot affect the subsurface geology. However, the subsurface geology probably influences management decisions indirectly through subsidence rates and depth of and compaction potentials of overlying soils.

This is a significant resource mangers can't influence but ignoring it in their planning process could reduce their potential level of success in the long-term.

4.9.10. Surface Geomorphology

The naturally higher elevations are boundaries to water movement and, thus, play a role in where water moves. Man, however, through his efforts to extract petroleum resources, enhances the efficiency of and stimulate the growth of waterborne commerce, delineate property boundaries, conduct agricultural operations, protect against flooding, and improve habitat and recreational opportunities, has created surface landscape features (e.g., levees, canal systems, water control structures) that have created localized alterations that overlay and in many instances override the natural surface water movement patterns throughout much of coastal Louisiana.

The surface geomorphology of Louisiana's coastal marshes has been unquestionably modified by management and other socioeconomic pursuits. That trend is expected to continue with all the concomitant implications to hydrology, marsh vegetation dynamics and socioeconomics.

4.9.11. Hydrology: Water

In Louisiana's coastal marshes, marsh water levels are influenced differentially in space and time by winds, river stages and Gulf of Mexico tidal dynamics (Gosselink 1984; Gosselink, Cordes and Parsons 1979). The water that flows into, over and through Louisiana's coastal wetlands comes from intercepted rain, storm water runoff from uplands, rivers and from the Gulf. Seasonal and yearly rainfall, river and tidal dynamics have been characterized, and vary across the Louisiana coastal zone. They form an ever shifting mosaic of mixed sources. Project site characterizations, however, are generally assumed or inferred from observations, the vegetation and measurement of a limited number of variables.

The amount and duration of water level change over and

within the upper several inches of the soil profile appears to be significant in determining plant distributions and species assemblages. Frequency of flooding is a measure of how often water occurs (e.g., an area may flood three times per month). Duration of flooding is a measure of how long an area remains flooded. It can be expressed per event (e.g., an area was flooded once for three days) or cumulated (e.g., an area was flooded twice, each time for three days, for a total of six days during the growing season). Depth of flooding is a measure of how deep the water is (e.g., the flood waters were three inches deep over the marsh surface). When it comes to marshes and their management, flooding frequency, duration and depth (especially relative to the root zone) can exert individual influences but as interacting attributes of hydrology are even more powerfully influential. At a project site these attributes are seldom quantitatively profiled as part of the planning process. Rather, the project is designed to adjust them on an on-going basis.

Water moves at different speeds into, through, across and out of vegetated areas and open water. Organic marsh and pond soils are typically more mobile than mineral soils. As such, slowing water velocities reduces mechanical marsh

How fast water moves influences other attributes commonly recognized as important to the health of marshes (e.g., sediments, soil and surface water salinities, marsh soil transport, dissolved nutrient levels, waste removal). The collective relationship between slower moving water and those attribute has yet to be characterized comprehensively.

One undeniable fact is that Louisiana's coastal marshes exist because of the hydrologic circumstances dictated by the historic, current and continuing relationship between the Gulf of Mexico and the Atchafalaya and Mississippi River systems. Affecting when, where and how fast water enters, resides within and leaves managed marsh areas is expected to be a continuing cornerstone of management.

As Louisiana's coastal marshes are the products of hydrology, affecting this significant resources has unavoidable consequences. Some significant resources are beneficially affected, others adversely affected. To what degree manipulating this significant resources will succeed at forestalling or slowing, stopping or reversing marsh losses on a repetitive and predictable basis is inconclusive.

4.9.12. Hydrology: Sediments

Sediments are either mineral or organic. Organic sediments

can be transported to an area by way of winds, water or man's action or produced within an area from plants and animals. Mineral sediments can be transported to an area in the same way but can't be produced within the area.

Sediment budgets on coastal, regional, basin and project site scales are characterized in qualitative terms and inferred from aerial photographs, observations and the literature. Enriching sediment budgets with increased production/retention of organic materials in managed areas when mineral sediment inputs are believed to be inadequate to keep pace with subsidence have been proposed as a way to reduce the deficit and/or create a surplus of sediment.

Shallow open water areas apparently are temporary repositories for sediments before moving further toward the sea. Tides and storms apparently play a key role in the movement and retention patterns of marsh sediments. The dynamics of sediments presented to and that do move through or over water control structures or perimeter embankments, and to what degree any such sediments are delivered to the marsh surface and retained, has been studied in part but is still largely assumed.

Louisiana's coastal marshes exist as a product of the historic sediment history dictated by the relationship between the Gulf of Mexico and the Atchafalaya and Mississippi River systems. Affecting when, where and how fast water enters, resides within and leaves managed marsh areas is expected to be of continuing and perhaps heightened consequence of future management efforts.

4.9.13. Hydrology: Salinity

Some of the water that flows into, over and through much of Louisiana's coastal wetlands comes from the Gulf. The Gulf is the source of salinity. A general inland advance of salinity has occurred over the years.

Although there is no compelling evidence for any on-going general tend of increasing salinity (Fuller et al 1990; Wiseman, Swenson and Power 1990) that might itself approach a lethal threshold, salinity trends can vary locally on sub-basin scales (Wiseman and Inoue 1993). Salinity regimes exhibit patterns related to seasonal and yearly rainfall, river levels (Gagliano et al 1973) and storm events that have coastal, regional, basin and individual project site signatures (Gagliano et al 1973).

The result is a shifting mosaic of salinity concentrations even at the local scale. Suppression of average and/or peak salinity levels is often an attempted management measure,

especially in fresher marshes. The type of structure and management program appear to influence how much salinity suppression can be achieved.

Historically, successfully controlling project site salinity has very often been considered a requisite for successful management. That perception was apparently often dictated by the relative emphasis between the purpose(s)/goal(s) of the project. A need to control salinity will continue to be a tool available to managers in their efforts to manage marshes.

Attempts to control salinity within managed areas is a way to affect a change in some other attribute of the targeted marsh. Efforts to control salinity have typically been judged according to the purpose of the project (Craft and Kleinpeter (1989). Results have been mixed. Average salinities have tended to decrease or remain about the same, but local rainfall patterns and retention of strom waters (DeLany 1988, Meeder 1989) can prolong the duration of elevated salinity conditions. Monitoring results also suggest that salinity gradients can also arise within managed areas (Roberts and Sauvage 1988, Anonymous 1989?).

The monitoring results reported by Clark (1989a) and Rogers, Herke and Knudsen (1987, 1992) and Turner, Day and Gosselink (1989) are considered representative of how variable most salinity responses can be to management. Typically designed and operated management programs, but for the unpredictability of local climatic, tidal and storm influences, probably would tend to lower average salinities. However, the type of structure used can also have an apparently great effect on the salinity regime. For example, Rogers, Herke and Knudsen 1987·reported salinities within areas managed by two different weir were on the average lower than behind the slotted weir. However, salinity behind the fixed-crest weir exhibited a cyclical patterns of alternating periods of several days with lower than average salinity followed by periods of several days with higher than average salinity. In contrast,salinity behind the verticle-slotted weir on average was higher than behind the fixed-crest weir but varied a great deal lees about the average. The average salinity behind the fixed-crest weir was lower but the amplitude of the change and variation over time was much less behind the verticle-slotted weir. The effects on the marsh vegetation would depend on the tolerances of the plant species that comprise the targeted marsh.

4.9.13.1. Concentration/Duration

Long-term Gulf salinity levels have not increased, but they

do exhibit year-to-year and seasonal variations. Rainfall, upland runoff, and the salinity concentration of water available to dilute Gulf waters interact to influence surface water salinity concentration gradients at local, basin-wide, regional and coastwide scales. However, once within a marsh, surface water salinities can be additionally modified through the expression of tides, gravity (or pump controlled) drainage, windspeed and direction, and evapotraspiration.

Salinity, especially as it affects soil growth conditions, is a significant modifier of plant growth conditions (DeLaune, Pezeshki and Patrick 1987; Craft and Kleinpeter 1988; Latham, Pearlstein and Kitchens 1991; Linthurst and Seneca 1981; Meeder 1989; Pezeshki, DeLaune and Patrick, Jr. 1987b; Webb 1983) with potential deadly consequences (Pezeshki, DeLaune and Patrick 1987a; Webb 1983). Daily, monthly and seasonal climatic variations affect both local water level dynamics and water chemistry conditions (Barlow 1956).

4.9.13.2. Depth/Penetration

Soil water salinity concentrations, especially throughout the root zone, also influence marsh plants and the structure and function of marshes. Soil water salinities can be lower but generally are higher than surface water salinities at any given time. However, the probability that soil water salinities will rise increases if higher surface water salinities remain in an area. Surface and internal drainage characteristics of the soil influence how quickly and deeply higher salinity waters may penetrate as well as how quickly any changes may be reversed.

Surface water salinities tend to exhibit higher levels during the summer months. During the summer, tidal heights and monthly average rainfall volumes are a little higher but the range in tidal changes is smaller. The result is that somewhat saltier water conditions occur nearer or at the marsh surface. During the summer, rainfall is also typically very spotty (associated with localized thunderstorms) and daily temperatures rise persistently to nearly yearly highs. Water evaporates more rapidly than at other times of the year and the marsh plants' requirement for water with tolerable levels of salinity is near the yearly high. The salinity concentration of slow moving or stagnant surface water can rise to stressful or even toxic levels.

Regardless of marsh type, salinity, in combination with low or no oxygen soil conditions in the root zone, can, as the result of chemical reactions can affect/immobilize plant

nutrients (Pezeshki and DeLaune 1990; Day et al 1989), immobilize plant nutrients, affect plant physiology (Pezeshki, DeLaune 1987; Pezeshki et al 1989) and growth patterns (Pezeshki and DeLaune 1990; Pezeshki, Matthews and DeLaune 1990), and, if conditions persist, can accentuate the build-up of compounds toxic to plant growth (Pezeshki, DeLaune and Pan 1991; Mendelssohn, McKee and Patrick 1981). Prolongation of such conditions can lead to the death of many if not all of the affected marsh plants (Koch and Mendelssohn 1989).

The role of salinity as a locally important modifier is evidenced in two ways. Salinity can affect which marsh plants occur where based upon individual plant species' salinity tolerances (Chabreck 1972, Sasser 1977, Smart and Barko 1980). Salinity can also affect the presence or absence of marsh plants via salinity's ability to influence marsh soil chemistry (Linthurst and Seneca 1981; Meeder 1989; Pezeshki, Delaune and Patrick 1987; Craft and Kleinpeter 1988; Latham, Pearlstein and Kitchens 1991)

Marsh losses have been shown to be the result of more than just salt water intrusion, erosion due to tidal action or waterlogging. Within any single tidal marsh type, salinity levels could often be a secondary problem. But, it would be a mistake to ignore salinity, especially if the average and long-term trend is increasing relative to the tolerances of the native plant species or the plant species that would result from management, or the managed areas encompasses more than one marsh type. In such cases, management, such as hydrologic restoration, that strives to maintain ambient salinity differences across the included marsh types but within tolerances would seem to have a greater potential to perpetuate the include marsh types.

4.9.14. Hazardous, Toxic and Radioactive Wastes

The potential for any such substances to be present at any given site is acknowledged. However, it is beyond the scope of this PHMEIS to conduct initial site assessments for each and every candidate project. At a minimum, an initial site assessment has been or will be performed by the Federal agency that sponsors a CWPPRA hydrologic restoration and marsh management project that are included on priority lists and are subjected to advanced design and analysis.

4.9.15. Marsh Microorganisms

Marsh microorganism are generally poorly studied (Day et. al., 1989; Mitsch and Gosselink, 1993). Although we know something about what they do, for example that they have a role in nutrient cycles, comparatively little is known about

what species is doing what.

Marsh microorganisms are involved with mediating nutrient dynamics and nutrient and energy cycling. Shifts in their community composition or structure will, therefore, affect nutrient and energy dynamics of the affected marsh.

As a group bacteria are capable of converting inorganic materials into several different forms that once converted become available for uptake by other biological forms. Bacteria can themselves incorporate inorganic materials into organic (carbon-based) substances. But other kinds of bacteria, along with fungi and viruses, can do the reverse....initiate and accelerate the break down of organic matter into constituent parts for repackaging and recycling within the marsh system. Fungi begin mechanically breaking down plant materials almost as soon as plants die, almost immediately rendering the newly-exposed surfaces susceptible to the action of associated bacteria. Those very same bacteria and fungi serve as food for species of protozoans and zooplankton.

If turbidity levels reduce light penetration, low or no oxygen may be available from photosynthesis dictating the predominance of anaerobic microbiotic activity. How fast water is exchanged, relative to nutrient concentrations and exposure time of organic matter to microbial activity with a given marsh setting, can influence marsh dynamics. For example, if the microbially-mediated break down of some plant or part of a plant takes several months but flows are elevated or exchange times are shortened, incompletely "digested" material is exported from the marsh. Also, if flows or exchange times are interrupted long enough, too little or no flushing of toxic biometabolites occurs, stressing the marsh system.

Management of water levels and water chemistry can directly affect microbiological communities of marsh soil and the water column. Because management of water levels and water chemistry are and will continue to be effective management tools, differences between the microbiology of managed and unmanged coastal Louisiana marshes can be expected to occur. Characterizations of what those differences are and their implications are not fully developed.

This significant resource is unavoidably affected by management. But as an intermediary, the implications of those affects can only be framed relative to the response of the soil types included in the managed area, how management affects water chemistry, water temperatures and hydrology. Although these apparently remain to be described in managed Louisiana marshes, a possible reaction would be that which

has been reported from Kelley, McKellar and Zingmark (1986) from a managed South Carolina impoundment. The response is one of unavoidable, reciprocal and compensatory shifts in numbers, biomass and probably species assemblages.

### 4.9.16. Phytoplankton

Phytoplankton are single cell, photosynthetic plants. Unattached forms of algae in the water column, they move where water moves. Phytoplankton, like other plants, convert inorganic carbon (as carbon dioxide gas) and dissolved nutrients (e.g., nitrogen, iron, phosphorous, silicon) into living tissue. They are a major food source for animals in the water column (e.g., zooplankton, plankton-eating fish) and sediments.

Phytoplankton may exhibit seasonal differences and spatial patterns. Nutrient, salinity and turbidity levels and circulations patterns can be quite different over small distances within any given marsh. Locally, differences are, therefore, likely to be quite great. Seasonal differences may be notable at the regional and coastal scales.

Because they are photosynthetic, light is a major controlling factor. Photosynthetic activity is related to the amount and frequency of light waves. Above or below species-specific thresholds, photosynthetic activity stops or is inhibited. Thus, turbidity levels that reduce or preclude light from penetrating throughout the water column, whether of marsh ponds or over the marsh during flooding situations, influence the rate of photosynthesis. However, even a turbid water column, if sufficiently mixed, photosynthetic activity can be sustained, if at a reduced rate.

A shortage of any one of the inorganic nutrients would limit phytoplankton. Nitrogen (as ammonium) is potentially more limiting than phosphorous to phytoplankton and competition with bacteria for inorganic forms of these nutrients can occur (Day et. al., 1989).

Photosynthesis consists of a series of biochemical reactions. Therefore, temperatures can influence the rate at which those reactions occur. Each species has a specific maximum temperature beyond which biological activity diminishes. In general that upper range extends from a low 50 degrees Fahrenheit to a high near 90-100 degrees Fahrenheit (Day et. al. 1989). Temperature optima for local phytoplankton populations reflect the local temperature regime and shifts in response to temperature changes can occur within about a day. For example, during winter phytoplankton species differ from those in summer and

phytoplankton activity is lower.

The amount of organic matter produced within a marsh in the form of phytoplankton can equal and may exceed the amount of organic matter in emergent and aquatic plants.

Management affects nutrient, salinity and turbidity dynamics and circulation patterns, all of which influence phytoplankton. And, these attributes can differ over small distances. Phytoplankton differences between and within managed areas should be expected. Characterizations of what those differences are and their implications are not fully developed.

This significant resource is unavoidably affected by management, and significantly so adversely during extended water level reductions. The implications of those affects can only be framed relative to the response of the soil types included in the managed area, how management affects water chemistry, water temperatures and hydrology. Although these apparently remain to be described in managed Louisiana marshes, a possible reaction would be that which has been reported from Kelley, McKellar and Zingmark (1986) from a managed South Carolina impoundment. The response is one of unavoidable, reciprocal and compensatory shifts in numbers, biomass and probably species assemblages.

4.9.17. Nutrients

The Ph (i.e., hydrogen ion concentration) is a log-scale measure of the chemical status within marsh surface and soil water environments. The scale ranges from acid through neutral to basic. The Ph of surface water is largely influenced by the source of the water and any dilutions. Marsh soil water is influenced by several electrochemical and biologically mediated reactions that occur within marsh soils.

Surface water temperatures exhibit seasonal, daily and localized differences. Water temperatures are lowest during the winter and early spring and highest during the summer and early fall. Shallow water areas can exhibit greater daily variations than do deeper water areas. Additionally, localized rainfall events (e.g., thunderstorms) can lower shallow surface water temperatures rapidly.

Oxygen is important because of its essential biochemical role in higher marsh life forms such as zoo and phytoplankton, benthic worms, fish, birds and mammals. For those organisms dissolved oxygen levels dictate the potential for the water to sustain life functions. Oxygen-using marsh species exhibit different thresholds of minimum

necessary dissolved oxygen levels. For example, menhaden require higher minimum levels of dissolved oxygen than do crabs.

Dissolved oxygen levels exhibit patterns in space and time. As water temperatures rise during the warmer months, less oxygen occurs per unit volume of water. Dissolved oxygen levels typically differ between nighttime and daylight hours. Water surfaces are generally more well oxygenated than are deeper depths in ponds.

Slower moving waters may exhibit lower dissolved oxygen levels than waters that are more strongly influenced by tides and winds. Rainfall from thunderstorms can locally change dissolved oxygen levels as can pumped inputs and river diversions.

However, oxygen is not essential to many marsh forms and is toxic to some marsh life (e.g., anaerobic bacteria). Bacteria, and some algae, are examples. Instead of oxygen some microorganisms can use nitrogen, while still others rely upon sulphur to perform the biochemical duties that oxygen performs for other species.

Nitrogen and sulphur occur in various organic and inorganic forms in the different Louisiana coastal marshes. They also occur at different depths within the marsh soil profiles and exhibit seasonal differences as well. Correspondingly, microorganisms exhibit a diversity that reflects those differences as well as many others. The interrelationships are the routes by which nutrients and energy flow into, through and out of Louisiana's coastal marshes.

Nitrogen, iron and phosphorus are very common chemical constituents of the marsh environment and along with sulphur, regulate plant growth. Those same chemical constituents are themselves influenced by marsh soil bacteria. In turn marsh soil bacteria are influenced by temperature, oxygen levels and Ph.

Nitrogen can be the most limiting plant nutrient in flooded marsh soils. Nitrogen is an essential constituent of amino acids, building block of protein. Organic matter (both locally produced as well as imported) and the atmosphere are principal sources of nitrogen. Atmospheric nitrogen dissolved in water is made available (as ammonium) to marsh plants and phytoplankton through the action of a group of bacteria and algae in the portion of the soil profile that lacks oxygen. Organic nitrogen (e.g., plant biomass, detritus) is converted to a form (ammonium ion) that can be used by plants directly and/or can be converted by other microorganisms to another chemical form that is also useable

by plants provided there is an oxygenated soil surface layer. If there is no surface oxygen layer in the marsh soil profile, the ammonium concentration can build up to levels that can stress or kill marsh plants. Nitrogen is lost through the export of organic matter, as an ionic form that is very mobile in solution, or due to the conversion of organic nitrogen to nitrogen gas affected by another set of microorganisms that thrive in the absence of oxygen.
Iron, as a plant nutrient, is not limiting to marsh plant growth. However, its chemical behavior in marsh soils can result in the creation of an iron compound that can be stressful or toxic when it rapidly joins with phosphorous. Iron exists in two forms in marsh soil water. One form is soluble and, therefore, available to plants as a nutrient. The other form is not soluble. The soluble form is electrochemically converted to the insoluble form in the presence of oxygen and when the Ph is neutral or basic. However, that conversion occurs many times more quickly when a certain kind of bacteria is present to act as a biologic catalyst. This is a reversible reaction.

Phosphorous is not a limiting plant nutrient but, like iron, it's chemical behavior in marsh soils can be influential. Phosphorous inputs include point-source outfalls (e.g., sewerage treatment plants), transported mineral sediments (with their electrostatically attached phosphorous) and dissolved inorganic and organic forms. Some marsh bacteria convert dissolved organic phosphorous to dissolved inorganic phosphorous and this conversion occurs more vigorously in winter when oxygen levels are higher and temperatures are cooler and algal compositions reflect those seasonal differences. Other kinds of marsh bacteria transform available dissolved inorganic phosphorous into organic phosphorous. As soils become lacking in oxygen, inorganic phosphorous attached to clay particles is released and iron-phosphorous complexes break down releasing soluble phosphorous forms. Shifts in Ph through the production of organic acids (e.g., sulfuric acid) can also release complexed phosphorous but in acid conditions phosphorous is quick to bind to clay particles. These reactions occur both in the water column as well as marsh soil water.

Sulphur, like nitrogen, can occur in several forms and bacteria and other microorganisms are influential. Sulphur concentrations, as sulphate, in sea water is very high. The conversion of sulphate to hydrogen sulfides is not Ph limited as are some other reactions and occurs as the result of bacterial action in the absence of oxygen. Sulfides are directly toxic to microorganisms and have been suggested as the reason inland marsh plants (where drainage is typically poorer) exhibit lower vigor. Sulfides can affect marsh plant growth because sulphur becomes less available for

plant growth and as do zinc and copper, other micronutrients, when they complex with sulfides. Additionally, sulfides, when exposed to oxygen (such as during a managed water level reduction), can be chemically converted to sulfuric acid which is also stressful/toxic to marsh plants.

Management of water levels, sediments, flow patterns and water chemistry can directly affect the chemistry of marsh soils, the structure and function of the phytoplankton and microbial components of managed marshes. Because water level regimes are often very similar between managed areas, management's effects on nutrient dynamics should be a function of the total area involved in management, sources of microbial communities and how the chemistry of the involved soils and the phytoplankton and microbial community components respond to management.

Management unquestionably has an affect on nutrient dynamics within managed Louisiana marshes. Cahoon and Groat (1990) did not include this significant resources in their study efforts. Apparently, they remain to be characterized. The South Carolina studies did not address this significant resource either. (see Primary Production).

4.9.18. Primary Production

Gross primary production is the energy entrapped through photosynthesis. Net primary production is gross primary production minus energy used by photosynthetic organisms to maintain life functions (respiration).

Soil or water column bacteria, phytoplankton, submerged and floating aquatic vegetation, and emergent vegetation all contribute to gross and net primary productivity of marsh systems, whether or not the marsh in question is managed.

Several papers describe observations or relationships. Others report on how statistically certain a studied relationship may be, infer biological relationships and then offer conclusions, explanations, or applications of the relationship. Others demonstrate a cause and effect relationship. Individually, those focused on some very interesting but quite limited aspects of primary production in marshes.

Studies that individual or collectively addressed or measured the effects of management on gross and net primary production or compared those attributes against unmanaged Louisiana marshes probably exist but in forms that are not readily retrieved. Cahoon and Groat (1990) did not address the matter of overall primary production between managed and

unmanged marshes.

How does management affect primary production? The question could equally well be asked in two parts: 1) can management enhance primary production,and if so 2) can it enhance it enough to offset erosion?

The answer the first part of the questions is a qualified yes. Managers have traditionally strongly emphasized adjusting environmental conditions to increase the production of plant biomass by the aquatic, especially submerged aquatic, and emergent plants of targeted marshes. Managers can point to instances when the production of aquatic and emergent plants increased as intended. In those instances, managers have successfully increased the production of those contributing sources. But there is more to the answer. Studies of primary productivity in managed South Carolina coastal, tidal marshes may be insightful. Kelley and Porcher (1986) examined macrophyte productivity, Marshall and McKellar (1986) examined aquatic community metabolism and Zingmark (1986) examined production of the microbenthic algae. Kelley, McKellar and Zingmark (1986) then presented a summary and comparison of productivity in managed and unmanged areas. They concluded that the overall average production in grams/meter was nearly identical in managed and unmanaged areas. They reached: "....two general conclusions based upon these pooled comparisons....(1) impoundment system productivity is quantitatively similar to tidal marsh system productivity at Cat Island and at some other locations along the East Coast of the United States; and (2) the contribution of aquatic community (benthic microalgae, phytoplankton, and submerged macrophytes) to system productivity is greater in impoundments than in tidal marsh and has compensated for the lower productivity of some impoundment macrophyte species" (Kelley, McKellar and Zingmark, 1986). At this time those findings might be as good as any other representation of how primary productivity is affected in managed Louisiana marshes.

Now to the second part of the question...can enhanced productivity offset erosion. At least for the situation at Marsh Island, Nyman, Chabreck and Linscombe (1990) state:

> "Marsh Island has few canals; therefore, marsh loss resulted primarily from natural processes. Weirs may have different effects under different hydrologic conditions; additional studies are needed before generalizations regarding weirs and marsh loss can be made",

a conclusion that reinforces the observation made by Nyman et al (1994) that marsh loss mechanisms can vary spatially

even within small geographic areas.

Nonetheless, the biomass of plant material from emergent and aquatic vegetation can be increased in some instances, often times requiring the extraordinary measure o using a pump (Lehto and Murphy 1989), but not with any apparent degree of consistency because of the linkage with successful water level reductions, which hints that the applicability of the endeavor may have different implications between areas subjected to marsh management versus some forms of hydrologic restoration. Certainly in areas subjected to marsh management, and some forms of hydrologic restoration, retention of the additional material may be greater. But the early evidence suggests that actively managed semi-impounded areas have significantly different short-term and apparently different long-term sediment budgets than do unmanaged areas. Hydrologic restoration is virtually unstudied in this regard. Thus, a definitive answer probably has to wait until the sediment budgets and plant responses are better understood.

Trying to draw conclusive insights about primary productivity in managed and unmanged Louisiana marshes from managed and unmanged South Carolina marshes is risky. What can be concluded, however, is that enhanced production of macrophytes in managed Louisiana marshes may not be conclusive evidence that overall primary production increases correspondingly or that erosion can be reversed or stopped. The possibility does exist that erosion might be retardable to some unknown degree by enhancing two of the contributing components to primary productivity in some management situations.

4.9.19. Secondary Production

Unicellular zooplankton (organisms that eat phytoplankton and bacteria), and the organism that comprise the multicellular marsh dependent organisms {e.g., invertebrates (polychete worms, oysters, amphipods, shrimps), fishes, reptiles, amphibians, birds and mammals} all contribute to gross and net secondary productivity of marsh systems, whether or not the marsh in question is managed.

Managers have traditionally set as their goal increasing the harvest of furbearers, alligators and waterfowl. Managers can point to instances when their efforts have achieved demonstrable success in increasing the production of aquatic and emergent plants by undertaking actions to stabilizing water levels, reduce water velocities, dampen tidal action and suppress salinity.

Most papers describe observations or relationships. Others

report on how statistically certain a studied relationship may be, and/or infer biological relationships and conclude with explanations or management implications of the relationship. Others demonstrate a cause and effect relationship.

Individually, many very interesting associations have been insightfully documented to various degrees. Collectively, however, we have been unable to find any single study or collection of studies of Louisiana coastal marshes that rigorously measured the effects of management on the range of species that contribute to secondary production of managed marshes or compared those attributes against unmanaged Louisiana marshes. Therefore, the effect of management on secondary productivity of Louisiana managed marshes in general or any specific managed marsh remains to be demonstrated. Thus, studies of components that contribute to secondary productivity from managed and unmanaged tidal South Carolina marshes may be insightful.

Many of the profiles of biologic resources that follow were derived and summarized from Day et. al. (1989) and Mitsch and Gosselink (1993).

4.9.19.1. Zooplankton

Zooplankton are small organisms. They are classified by size. The biggest forms are about 0.05 inches long. The smallest forms are microscopic and unicellular. The movements of plankton are controlled by the movements of the tides and currents. Some species can swim weakly, jellyfish being an example of large-sized species that can swim. Immature stages of marsh dependent species are also classified as plankton. Benthic worms, shrimp, crabs and many fish species are examples.

Zooplankton are "transfer agents." They concentrate nutrients and energy when larger forms of plankton prey upon and may influence the population size of smaller zooplanktors. Zooplankton are food for larger species, thereby serving as consumable nutrient and energy particles. Because of their higher numbers and feeding rates, short life spans and movement patterns intimately linked to water movements, zooplankton play a role in nutrient, especially nitrogen, dynamics. Some zooplanktors are a dispersal form in which species (e.g., shrimp) move between the marsh and nearshore waters.

Of the forms that spend their entire life as plankton, immature individuals of a single copepod species (Acartia tonsa) tend to predominate. That numerical dominance persist throughout the year with larval numbers tending to

peak in the spring in Barataria Bay, Louisiana. The smallest-sized plankton group consists of many more species and are significantly more abundant, even in Terrebonne Bay, Louisiana.

Temperature, food, predation and salinity are purported to be the main factors influencing zooplankton. Zooplankton occur over wide ranges of temperature and salinity. In Barataria Bay _A_. _tonsa_ occurred in waters with temperatures between 40 and in excess of 90 degrees Fahrenheit and with salinity that ranged from near zero to 30 ppt. In Louisiana's warmer waters, zooplankton can be expected to exhibit several generations each year but temperature probably does not influence species composition. Zooplanktors that eat plant material probably are not food limited, considering the amount of detritus that is available but predatory zooplanktors may be food limited.

Tolerances to temperature and salinity encompassed by the diverse planktonic community that apparently characterizes Louisiana's coastal marshes appear capable of offsetting single species reductions due to salinity sensitivity or temperature.

If quantitative studies comparing the structure and function of the zooplankton communities in managed and unmanaged Louisiana marshes have been performed, they are not readily retrievable. Taniguchi's (1986) study of managed an unmanged marshes in South Carolina is, therefore, indirectly insightful. He measured changes that occurred in the numbers of several zooplanktor populations, temperature and salinity over more than a year in managed marshes and in an adjacent tidal creek in unmanaged marsh. He recorded unexplained differences between ponds. However, he also recorded population compositions and standing crop densities in ponds that were statistically similar to and occasionally significantly higher than what he recorded in the creek. He observed that within several weeks zooplankton population densities returned to prewater level drawdown densities. He concluded that management of ponds does not separate planktonic fish larvae and their food and that differences between managed ponds and unmanaged marshes tended to be short term.

4.9.19.2. Benthos

Benthos is an inclusive term that can refer collectively to the plants, animals and substrates that are the bottom of ponds and the medium in which marsh plants are rooted. The common tie among benthic species is where they are more so than what they are or do.

Oysters, crabs and shrimp are members of the benthos. They are notable as much for their ecological interest as their commercial and recreational value.

Organisms that live within or on soils influenced by changing water levels must contend with the physical and chemical differences that arise from water level fluctuations. Seasonal changes in water chemistry are additional influential factors affecting distribution and abundance.

Earlier in this EIS, marsh and pond soils, bacteria, fungi and other forms were themselves identified as significant resources. Therefore, benthos was used in this section in a narrower context. It refers to the organisms that live within or on pond and marsh soils.

Some of the species are recreationally and commercially important directly to man. Other functions of some of these organisms can be inferred by examining feeding modes. Some benthic species tend to either filter food suspended in the water column or by nonselectively ingesting bottom deposits. Suspension feeders tend to occur more often in sandier-bottom areas whereas deposit feeders tend to occur more often in areas with siltier, more organic-rich bottom materials. Species in both groups tend to reside in the sediments. Other suspension feeding species group together on top of the water bottom. Grouped feeders slow current velocities, thereby possibly encouraging sediment deposition. Many if not all are food for some other organism. For example, many are food items for fish and migratory and resident wading and shorebirds.

Buried suspension feeders (e.g., clams), as well as group suspension feeders (e.g., oysters) extend siphons, actively draw in and filter water, extracting food (e.g., suspend detritus - with its community of associated bacteria, fungi, zooplanktors, phytoplankton), and pump-off the filtered water back to the water column. The generally immobile suspension feeders depend upon a supply of food carried to them by water movements. Oysters can extract up to eight times their own weight each day. Along with other suspension feeders they can have effects on turbidity, and nutrient cycling.

Deposit feeders ingest organic-rich sediments, either through siphons or while burrowing. They also derive their energy by digesting the ingested organic detritus as well as associated living tissue.

Both groups repackage organic matter. Buried species enrich the soil profile with their particulate excreta while

suspension feeders enrich the soil surface.

Another group of benthic organisms includes species that displace sediment particles as they burrow through the bottom materials. Different species assemblages occur within muddier soil profiles compared with sandier soil profiles. Regardless, burrowing increases exchange of water, oxygen and nutrients with the upper reaches of the soil profile and also increases the organic content of the soil profile. In Barataria Bay, Louisiana nematodes occurred only within the top inch or two of the soil surface. To what extent species may penetrate and are able to persist in soil conditions lacking oxygen in Louisiana's managed and unmanged marshes is an interesting question. Soil temperature may seasonally influence numbers because from Florida marshes at similar latitudes species from this group exhibited peaks during November and December.

A heterogenous benthic group includes highly mobile forms such as the shrimps and crabs. Those species could just as easily be perceived to be part of the fish community of the marsh but their feeding and other behaviors are linked to pond bottoms and marsh soils. These organisms actively burrow into the substrates to acquire shelter and/or food, graze food from surficial deposits, scavenge, and are themselves food items for other organisms, including man. The growth and breeding physiology and movement patterns of these species are influenced by water temperatures, salinities, and water movements, on daily, monthly and seasonal scales.

If quantitative studies comparing the structure and function of the benthic communities in managed and unmanaged Louisiana marshes have been performed, they are not readily retrievable. However, the average grain size, organic matter content and soil bulk densities are attributes of marshes that influence benthos. Marsh and open water/pond soils differ within and between basins and, therefore between regions and throughout Louisiana's coastal marshes exhibit differences in those same attributes. Corresponding patterns of benthos can be expected.

Managed marshes may exhibit differences between each other and certainly may exhibit differences from unmanaged ares. Stabilizing water levels or water level drawdowns are typical management options. Both are designed to change, but do so to different degrees, water flow patterns over and through the sediment profile, may change the oxygen profile in the soil, and may also amend the soil structure.

Areas managed with water level drawdowns are likely to exhibit difference from areas where water levels are

stabilized. For example, Day et.al. (1973) reported that the biomass of some benthic species was greater near the waters edge in a Barataria Bay, Louisiana, salt marsh. Thus, moving the waters edge down the slope of exposed sediments by lowering water levels for prolonged periods on a repetitive basis would likely have a different effect than just stabilizing water levels at or near the natural marsh edge. The biological significance of any such differences between the alternative water management options and unmanaged marsh probably remains to be quantified in Louisiana.

However, the diversity of species and sheer numbers of individuals of the benthic species that can and do reside on or in the soils of ponds and marshes argues for some degree of stability in the dynamic environment of a marsh.

Field data collections by Coull (1986), Wenner (1986a,b) and Olmi (1986) in South Carolina are suggestive of the potential for differences between managed and unmanaged marshes. All five managed ponds existed on the same tidal creek. Water level were drawn down but not identically.

These investigators recorded and compared changes that occurred in the numbers of benthic meiofaunal (from Sept 1982 and February 1983 - Coull, 1986), benthic macrofauna (during six selected two-day periods from January to July 1984 - Wenner 1986a), and decapod crustacean populations (regularly from January 1983 to December 1984 - Olmi; alternate months from March 1983 to December 1984 - Wener 1986b) in impoundments (that underwent water level drawdowns during May of 1983 and October and November of 1984; Coull, Wenner 1986a), at impoundment structures, to include a drawdown (Omni), and an adjacent tidal creek in unmanaged marsh (all).

Coull (1986) recorded the same species groups in managed ponds. However, the number of individuals per group between ponds was significantly different. Based upon a single sampling date in February, Coull recorded more species represented in unmanaged sites but recorded differences were not statistically significant. Variation within ponds precluded any definitive finding relative to substrate differences encompassed within managed ponds. He commented that the species assemblage in impoundments was similar to what occurred on high intertidal marsh in South Carolina. With only two sampling dates and because hydrologic integrity was lost in several ponds on separate occasions, Coull rightly characterized his results as preliminary.

Wenner (1986a) recorded statistically significant differences between and within ponds and between ponds and

unmanged areas. Despite the loss of hydrologic integrity in several [ponds on separate occasions, impoundments exhibited species assemblages different from unimpounded sites and fewer species. Animal differences were correlated with physicochemical (concurrent data collection) differences between managed and unmanaged areas. He concluded that animal differences were the result of a more physically stressful condition in the managed ponds that resulted from the water management regime as dictated by the management objective (i.e., foster the growth of widgeon grass), even when flow through was permitted. He postulated that predation effects could play as an enhanced role in structure benthic communities in the managed ponds.

Omni reported experiencing several experimental design problems that resulted from the design and operation of the water control structures. The consequence was reduced exchange and, therefore, reduced data collections. However, the design problems highlighted the basic findings of his study. He concluded that,

> "Utilization of the impoundments by target (shrimp and crabs) organisms was dependent on water exchange between Chaney Creek and the impoundments to provide access to the impounded area.....The degree to which a particular species was able to inhabit the impounded areas depended upon the timing of recruitment of that species and periods of water exchange between Chaney Cree and the impoundments."

The appearance of juvenile planktonic forms at the creek side of the water control structures followed seasonal life history patterns. However, water management schedules appear to be able to impart an unintended access bias advantageous more so to spring migrants and disadvantageous to later season migrants.

Wenner focused on characterizing decapod crustaceans from natural and impounded wetland areas. To facilitate his comparison, he pooled data from impoundments. By using pooled data, he statistically equated impoundments, despite the loss of hydrologic integrity on several ponds on separate occasions and some differences in water management regimes between ponds. In effect he measured something more like a "net" response over a range of natural and man-made situations managers of impoundments might encounter. In that unintended context, he reported that managed and unmanged areas were similar in many respects (species composition, temporal patterning, but also exhibited differences. Differences suggested in by his data were that structures and management regimes imposed access and retention selectivities of blue crabs and <u>Penaeus</u> shrimp.

These same at same conclusion would seem to apply to some degree fairly well to managed Louisiana marshes.

4.9.19.3. Wildlife and Fish, Crabs and Shrimp

The most likely response is an unavoidable reciprocal, possible compensatory shifts in numbers and biomass and probably species assemblages.

See also respective headings elsewhere

4.9.20. Marine Mammals and Threatened And Endangered Species

Dugoni (1975) looked at breeding habitats of bald eagles in forested wetlands just north of the coastal marshes in Louisiana. He found that eagles do not prefer certain nesting territories based on surrounding habitat availability alone. Dominant prey items included freshwater catfish and American coots indicated the importance of an abundance of wintering waterfowl and shallow lakes within the coastal zone.

Aquatic mammals (e.g., dolphins, seals and whales) do occur. Only the Atlantic bottle-nosed dolphin (Tursiops truncatus) typically occurs in the larger shallow open water bays adjacent to the Gulf where they forage for fish. All others can be recorded as rare or accidental records of species whose habits are oceanic. Whales are similarly characterized.

4.9.21. Socioeconomics

Man is a significant resource. His relationship to the marsh and its management can be gauged collectively as socioeconomics.

A decision to manage a marsh is often motivated by socioeconomic interests. Socioeconomic decisions are expected to continue to influence decisions to manage Louisiana's coastal marshes. The LaDNR- Coastal Management Division also accounts for socioeconomics in their permit process (Broussard et al 1989). CWPPRA is a recent manifestation of that trend.

The following was summarized from the Socio-economic Appendix (Appendix J).

4.9.21.1. Fish and Wildlife Resources

4.9.21.1.1. Commercial

For the period 1984 to 1993, Louisiana, on average, has accounted for 19 % of the United States' total fisheries landings (weight basis). Louisiana's 1993 landings were valued at $261 million, second only to Alaska's $1.4 billion.

Over that same time period, declining total yearly landing weights occurred. Reductions of marsh quality, marsh quantity and over fishing were noted as reasons landings may have declined.

Foreign competition, regulatory requirements, aquaculture and the effects of recreational fishing were identified as economically influential. Nonetheless, commercial fishing endeavors still supports a wide range of related businesses that are estimated to employ about 90,000 individuals and an economic impact of $ 1.5 billion.

During the 1972 to 1992 time frame, the number of alligators harvested increased from 1,350 to more than 24,000. Correspondingly, the value has increased from about $75,000 to $13.5 million.

Conversely, the harvest and value of other furbearers has declined. During 1945-1946, over eight million muskrat pelts were taken. From 1978-1993, only slightly more than 250,000 pelts per year (average) were taken. Several economic and social factors are identified as potentially responsible. An interesting side effect is the concern expressed by some landowners that overpopulation, that have gone largely unaffected by trapping, of some furbearers is contributing to marsh losses.

4.9.21.1.2. Recreational

A steadily increasing number of anglers seek bass in the fresher marsh types. As of 1984, about 180,000 licensed saltwater anglers annually spend $181 million and have nearly one billion dollars invested in boats, gear, camps, and other equipment.The annual economic impact is estimated to be between $500,000,000 and $900,000,000 for 1984-1985. Recently, the economics of recreational fishing have been contrasted with the economic impact of commercial.

Waterfowl hunting is a very popular pursuit. Annually, it has an economic value of $10 million.

More than 3,000,000 user days are expended each year recreationally fishing and hunting.

4.9.21.1.3. Management Implications

A direct economic relationship has existed, does exist and is likely to continue to exist between Louisiana's coastal wetlands and the commercial and recreational pursuit of several marsh-dependent organisms. One management implication is that commercial and recreational interests can be prolonged by implementing management efforts that result in suppressing, stopping or reversing marsh losses, prolonging the more productive marsh types, and/or converting less productive marsh types to more productive types.

Documenting the economic consequences of individual permits to fish and wildlife resources has proved very difficult. The NOD has and continues to work with the NMFS to characterize the economic implications of individual permit actions. Thus far, those efforts have proven fruitful only when comparing alternatives for individual projects.

4.9.21.2. Flood Control

Historically, the Louisiana coastal marshes have been subjected to periodically high river stages, storms and hurricanes. A social and economic initiative to provide protection from such events resulted in the creation of levee systems and the implementation of flood control projects. The consequence of those projects is reduced or diverted freshwater and sediment inputs to the Louisiana's coastal wetlands. Combined with the hydrologic effects of channels constructed for navigation and petroleum extraction, Louisiana's coastal wetlands are changing quantitatively and qualitatively as a result. Reduction in wetlands is believed by many to translate directly into reduced protection from strom-induced tidal surges. The management implication is that undertaking efforts to suppress the conversion of vegetated marshes surfaces to open water is socio-economically beneficial.

4.9.21.3. Land Use and Land Loss

Traditionally, water bottoms have been considered public property, along with the subsurface mineral rights. As of 1993, an estimated 900,000 acres of wetlands converted to open water since 1932. One issue that has significant economic implications is the retention of mineral rights by the landowner as marsh converts to open water. This is an issue of state law that was apparently addressed in the recently concluded 1995 session of the Louisiana State Legislature (SB333/Act 1332).

The management implication is that management of Louisiana's coastal marshes has and is likely to continue to have a role in addressing land use issues.

4.9.21.4. Mineral/Petroleum Production

Mineral/petroleum extraction has played a significant role in the economics of the state and the nation for several decades. Direct and indirect losses of coastal marshes in Louisiana occurred as result. Mineral/petroleum extractions are expected to continue.
The pace of that endeavor is uncertain.

Many previously permitted management plans included design contingencies to accommodate the reality that mineral extraction activities are likely to continue into the foreseeable future. The management implication is that such provisions should be retained and updated as access and extraction technologies change and management insights are also updated.

4.9.21.5. Displacement of Farms

Rice cultivation is the agricultural activity that is more likely to be immediately affected. Rice is a crop intolerant of salt. Therefore, salt water that intrudes into surface waters used for irrigating rice crops quickly those water unsuitable, forcing the grower to rely upon alternative water supplies.

The management implication is that efforts to control marsh losses may also have temporal and spatial implications to rice farming. Whether the management projects are accidentally or intentionally placed in a pattern that prevents or retards salt water intrusion makes no difference, although strategic citings are certainly possible.

The NRCS was invited to prepare a narrative on the relationship between management of coastal Louisiana marshes and prime and unique farmlands. That narrative is presented as Appendix K.

4.9.21.6. Other Business and Industries

A variety of businesses that function in support roles relative to the marsh-dependent/related economy (e.g., net makers and repairers, shrimp and bait houses operators, hunting guides, fur buyers, truckers) may collectively have a significant socioeconomic influence on the overall economy.

The management implication is that factions of the economy even are indirectly linked to the status of Louisiana's coastal marshes. Management efforts that either slowed, stopped or reversed marsh loss could have different effects

on those economic interests.

4.9.21.7. Property Value and Ownership

Camps serve as bases of operation for commercial and recreational pursuits related to the marsh. Many are accessible only by boat. Many are club houses, others are privately owned. Several thousand such camps are believed to exist throughout Louisiana's coastal marshes.

Protecting property values and securing property ownership in the face of marsh losses has and will continue to be a factor motivating interest in management of marshes.

4.9.21.8. Public Facilities and Services

4.9.21.8.1. General

Public facilities and services which influence or might be influenced by a demand for managing marshes are related to Federal and state agencies that have interest in: 1) promoting/managing fish and wildlife resources; 2) installing/maintaining flood control features; 3) hurricane evacuation and other emergency programs and facilities; 4) maintenance of existing navigation channels; 5) public and private environmental projects; 6) mitigation banks; 7) maintaining/operating existing infrastructure (e.g., roads, bridges, marinas); and, 8) state and Federal management/education holdings.

4.9.21.8.2. National Wildlife Refuges, Parks

There are several national wildlife refuges within the Louisiana coastal marshes. Their locations have been plotted on the Plates. The management of most of those refuges is focused on providing high quality life requisite resources for overwintering waterfowl. The remaining refuges provide habitat for other species of migratory or resident bird species, some of which may be endanger threatened or rare, and/or migratory marine organisms.

Subordinate activities, recreational waterfowl hunting and/or fishing is generally permitted on many of those facilities. Such activities typically occur on a limited basis and on a more highly regulated basis than generally is the case elsewhere.

4.9.21.8.3. State Wildlife Refuges/Management Areas, State Parks

There are several such state facilities within the Louisiana coastal marshes. Their locations have also been plotted on

the Plates. The state wildlife management areas provide a high quality hunting, fishing, and/or trapping public lands opportunity/alternative to members of the general public. Management of the state wildlife refuges focuses on providing high quality habitat and safe haven for migratory waterfowl and associated marsh-dependent species.

Subordinate activities, recreational waterfowl hunting and/or fishing is generally permitted on many of the facilities. Typically, both occur on a limited and more highly regulated basis than generally is the case elsewhere.

4.9.21.8.4. Management Implications

Management of Louisiana's coastal marshes have biological implications to the targeted marsh-dependent resources as well as the missions and goals of the affected governmental organizations and the general well being of the public.

4.9.21.9. Employment and Labor Force

Construction workers, environmental consultants, researchers, private and government scientists, regulators, land managers, contract trappers/fishermen are examples of some of the professions directly linked to the management of Louisiana's coastal marshes. With so many divergent interests, the long-range economic effects are not easily or precisely characterized. For some, such as state and Federal refuge and management area employees, operation of the managed areas is their only employment and principal source of income. For others, many of which may be retired, their participation with management may be an effort to supplement their incomes. However, the ultimate economic effect of any project or any collection of projects is related to what degree a project or projects succeed.

The implication is that the design, implementation, operation and maintenance of management efforts involve a wide variety of professionals.

4.9.21.10. Income

Salaries from direct employment are one component of income. Average annual salaries from the parishes that fall within the area covered by this EIS are nearly $2,000 below that average. Residual effects from the recent economic decline of the oil and gas industry were suggested as reasons.

Another source of income is leases. Oil and gas leases likely represent a potentially substantial source of income. Fur trapping, hunting and fishing leases and cattle grazing leases are other source of income.

The management implication is that many of sources of income are derived from or related to marshes. Management could have a substantial affect on them.

4.9.21.11. Displacement of People

Displacements of people can result directly from land loss or indirectly from reduced economics.

Others aspects of this issue that could be addressed under this heading but were not addressed in the socioeconomic appendix are addressed in as much detail as is currently available below.

4.9.21.11.1. Landowners and Limiting Public Access

There appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

We perceive the issue to be that landowners feel they are unilaterally exposed to the risks and costs of vandalism and liability claims if they are forced to provide uncontrolled public access to their property or are precluded from limiting access.

When it comes to the harvest of marsh dependent resources, we perceive the issue to be whether marsh-dependent resources (e.g., fur, fish, alligators, waterfowl) are public resources or wholly proprietary resources. The related issue is public access.

If marsh-dependent resources are proprietary, as is apparently assumed by many land owners, then the landowner, they argue, can deny access to his/her property to harvest on the basis of their being no public resource involved.

If there are public resources, then the landowner apparently feels he/she is exposed to added vandalism, trespass and liability claims if the public is allowed uncontrolled access to his/her property, the landowner is precluded from controlling access, or members of the public are enticed to trespass by the enhanced resources associated with the managed area.

4.9.21.11.2. Protecting Values Associated With Marsh Ownership

There are apparently two components to this concern: 1) preventing the loss of mineral rights/royalties; and, 2) capturing the economic values of harvestable marsh-dependent resources.

Regarding mineral rights, the issue is that under applicable state law, in general, mineral rights revert to the state as marsh erodes. Slowing or stopping marsh erosion precludes that reversion. This is presumed to be the basic motivation for landowners/mineral rights holders to elect to manage marshes.

Regarding the monetary value of harvestable resources, the basic issue is that this represents an interest landowners wish to wholly retain but is typically a relatively minor source of potential or actual income to most landowners. To a smaller number of landowners, capturing the economic values of harvestable marsh-dependent resources is the only source of income and is, therefore, of paramount importance. Either landowner group must content with the previously mentioned concerns of unwanted/uncontrolled access by the public, and vandalism and liability.

Management that succeeds at slowing or stopping marsh erosion benefits the mineral rights owners, furthers the missions of the Louisiana Departments of Natural Resources (Coastal Restoration Division) and LA WL&F but is counterproductive to the state revenue generating needs. However, this situation creates the apparent paradox that the interests of some state-level agencies could actually conflict with the interests of other state-level agencies.

4.9.21.11.3. From the Viewpoint of Members of the General Public

As was the case with the landowners perspectives, there appear to be three distinct components: 1) liability; 2) vandalism; and, 3) the harvest of marsh-dependent resources.

Regarding vandalism and liability, the issue appears to be that public harvesters/users feel they are improperly perceived by landowners/leaseholders as a group that is generally irresponsible. They believe this is a spurious argument for controlling access.
Regarding the harvest of marsh dependent resources, as we appreciate this issue, it has three parts: 1) public resources do not become private property simply by moving into privately owned marshes; 2) public resources, even when resident on private land, should be accessible by the public; and, 3) interfering with the free movement of fisheries organisms between privately owned, controlled access areas and publicly accessible areas adversely effects the culture, life style and economic fortunes of many people.

Access to the resource is the principal component, but ownership of the resource is also being questioned. Both

are questions of law, that need not and should not be resolved by this agency.

4.9.21.11.3. Management Implication

The management implication is that displacement of people is a complex problem apparently consisting of diametrically opposed perspectives. Resolution of the issues may not easily achieved if at all.

4.9.21.12. Tax Revenues

Management of Louisiana's coastal marshes likely contributes to the tax base through property, sales and income taxes.

The management implication is that successful management efforts have potentially positive effects on existing and future tax bases and revenues. The converse may also be true in the longer term.

4.9.21.13. Community and Regional Growth

Management of Louisiana's coastal marshes likely contributes to the potential for positive community and regional growth.

The management implication is that successful management efforts have potentially positive effects on existing and future community and regional growth. The converse may also be true in the longer term.

4.9.21.14. Health and Safety

Management of Louisiana's coastal marshes may contribute to the health and safety of communities and the region. This benefit arises from coastal marshes serving to reduce flooding. The success of the projects at slowing, stopping or reversing marsh losses would be correlated with the magnitude of the benefits.

The implication is that managed marshes in an eroding marsh system contribute to flood reduction.

4.9.21.15. Community Cohesion

The rich fish and wildlife resources of coastal Louisiana are a unifying feature in that commercial and recreational participants have expressed interests in the health and well being of the marshes and its associated and dependent resources. However, that same resource has been a source of friction. Those two interest groups are competitive users of the exact same resources that are dependent upon a diminishing resource base.

The management implication is that the forces that bind a community together and the forces that separate community elements are at both at work at the same time. Resolution of the issues may not easily achieved if at all, leaving community cohesion to improve or deteriorate as much with this issue as with any other.

4.9.21.16. Aesthetics

The marsh itself is an aesthetic attribute. So, too, are the resources and some of the activities that occur relative to the presence of water and marsh dependent species. The presence of oil and gas operation could be characterized by some as adversely affecting the aesthetics of the marsh.

The management implication is that the aesthetic value of a managed versus unmanaged marsh is in the eye of the beholder.

4.9.21.17. Noise

Because the coastal wetlands are largely unpopulated by humans, threats to human health on a large scale appear unlikely. However, noises associated with construction, maintenance and operation of managed area may pose a localized, short term threat. Some noises associated with activities associated with manage areas, (e.g., gun blasts while hunting) may pose a threat to the immediate health of participant.

Construction and maintenance induced noise can also have transient effects on animal species. Typically, it disrupts some aspect of their breeding biology.

The management implication to humans is to be responsible in performing installation, operation, maintenance and any other functions only when wearing protective hearing devices. The management implications for wildlife is to schedule or site potentially disruptive activities at times or places where the potential for disturbance is minimized or avoided as much as reasonably possible.

4.9.21.18. Environmental Justice

Executive Order 12898 requires all Federal agencies to seek to achieve environmental justice by "....identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects its programs, policies, and activities on minority populations and low-income populations".

Managing Louisiana's coastal marshes is not practiced in a

way that adversely or environmentally affects any specific groups or individuals. Nor does it differentially affect low income or minority populations.

4.9.21.19. Summary - Relationships Between Socioeconomic Attributes

The implication is that managing Louisiana's coastal marshes may have a much wider range of potentially significant individual and interrelated social and economic effects than perhaps routinely presumed by members of the public at large.

4.9.22. Cultural

Over 2,400 archaeological and historical sites exist within the hydrologic basins included encompassed by this EIS. Collectively, these site span the human occupation sequence of the state and represent Louisiana's long cultural heritage.

The prehistoric sites are predominantly Indian shell middens situated along the natural levees of rivers and bayous and surrounding shorelines of the coastal lakes. Archaeological evidence indicates that these prehistoric Indians gathered both freshwater and brackish water shellfish. These sites were habitation sites as well as camp sites for shellfish processing.

Historic sites date to colonial times and are also located on natural levees. Domestic buildings or their ruins, boat landings, hunting and fishing camps, farm and plantation buildings, shipwrecks, and military fortifications are examples of the existing resources. Many of the archaeological sites and historic properties have been determined eligible to be or are listed on the National Register of Historic Places.

The Cultural Appendix (Appendix L) includes a description of the procedures used to identify cultural resources associated with project sites and activities and actions taken to reduce/avoid adverse impacts to those resources or any discovered during construction of authorized projects. Those procedures were used during the processing of previously permitted projects.

An assessment of the potential to affect cultural resources can go no further at this time. To complete the assessment requires knowing precisely where management structures and construction and maintenance activities would occur. Once advanced project designs are formulated and an analysis of a project is initiated, the procedures used to characterize

and reduce/eliminate adverse impacts to resources encompassed within or nearby to previously permitted projects would be used during the processing of applications for future projects.

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **EMERGENT VEGETATION ON UNERODED NATIVE SOILS**<br><br>Of progressively greater interest to managers intent upon forestalling marsh loss, of increasing general interest in role related to forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br>Important Attributes<br><br>HYDROLOGY: Flooding Frequency<br><br>MARSH SOILS: Surface Elevation<br><br>HYDROLOGY: Sediments<br><br>MARSH SOILS: Composition<br><br>MARSH SOILS: Water Depth: | HYDROLOGY: Flooding Frequency MA[1]: depending upon the species, flooding either too often or too infrequently can be stressful/lethal<br><br>S[2]: Conclusively demonstrated<br><br>MARSH SOILS: Surface Elevation/Water Depth MA- Maintaining a water depth, in and over a marsh soil profile, that will support the sustained, vigorous growth and reproduction of emergent marsh grasses is essential; surface water depth typically subject to monitoring<br><br>S: Conclusively documented<br><br>HYDROLOGY: Sediments MA- Vegetation 1) aids in retaining sediments, 2) responds to sediment depositions, and, 3) sediment introduction/deposition accommodated only so long as it doesn't compromise other management goals; not typically subject to monitoring<br><br>S- 1) Conclusively demonstrated, 2) some experimental evidence, 3) reflected in water control structure operations schedules<br><br>MARSH SOILS: Composition MA- 1) not all marsh plants grow on all marsh soils, 2) a very common plant species of brackish marshes and the single most important plant species of saline marshes cannot grow on certain marsh soils, 3) in some cases changing the composition may be called for, but 4) can have adverse consequences, especially in organic soils<br><br>S- Conclusively demonstrated<br><br>MARSH SOILS: Water Depth MA- Periodic, repetitive reduction in soil profile/exposure of marsh substrates amends soil chemistry, thereby 1) invigorating plant growth, and 2) stimulating root growth; typically not subject to monitoring<br><br>S: 1) conclusively demonstrated, 2) some experimental evidence | HYDROLOGY: Flooding Frequency MA: See marsh management<br><br>S- See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>MARSH SOILS: Surface Elevation/Water Depth MA- See marsh management<br><br>S: See marsh management<br><br>HYDROLOGY: Sediments MA- Vegetation 1) aids in retaining sediments, 2) responds to sediment depositions, 3) is often a prominent feature, but in some cases 4) will be accommodated only so far as they don't compromise any other management goals<br><br>S- 1) conclusively demonstrated, 2) some experimental evidence, 3) evidenced in project designs<br><br>MARSH SOILS: Composition MA- 1) perpetuating the current situation is preferred, 2) only in a few cases may it be necessary or desirable to undertake actions that could result in modifying the soil composition<br><br>S- Intuitively appealing<br><br>MARSH SOILS: Water Depth MA- Periodic, repetitive reduction in soil profile/exposure of marsh substrates amends soil chemistry, thereby 1) invigorating plant growth, and 2) stimulating root growth; typically not subject to monitoring<br><br>S: 1) conclusively demonstrated, 2) some experimental evidence |

[1] MA = Management Assumption(s)

[2] S = Impression of support/insight from literature

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **EMERGENT VEGETATION ON UNERODED NATIVE SOILS** (Continued)<br><br>HYDROLOGY: Velocity<br><br>MARSH SOILS: Persistence<br><br>Species Assemblages<br><br>Production<br><br>See Also<br><br>**Primary Production** | HYDROLOGY: Velocity MA- vegetation 1) slows surface water velocities, 2) disperse wave energy, thereby reducing erosion rates, and 3) indirectly can be stressed/die from excessive velocities that erode marsh soils and expose roots<br><br>S: 1) conclusively demonstrated, 2) some experimental evidence<br><br>MARSH SOILS: Persistence MA: Fostering the production, retention and accumulation of sediments within the managed area can slow, stop or reverse marsh losses by 1) stimulating root growth, and 2) providing sites for plant colonization; subject to monitoring from aerial photos/ground inspection<br><br>S: Theoretically correct, intuitively appealing but magnitude of response seldom demonstrated, nearly always presumptive - remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Species Assemblages MA: Judicious manipulations of depth and duration/frequency of flooding and often salinity regimes can be used to 1) prolong and/or 2) expand the existence of existing assemblages, or 3) in combination with marsh burning, used to adjust/amend species assemblages; monitored<br><br>S: 1) & 2) basis for many permit requests, degree of success generally site/project specific, seemingly correlated with freshwater for dilution and/or adjustment of structures almost daily, 3) convincingly demonstrated<br><br>Production See **PRIMARY PRODUCTION** | HYDROLOGY: Velocity MA- 1) emulating some historic (often natural) condition is preferred, 2) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels/expose marsh substrates and/or seasonally manipulate pool stages to amend soil chemistry and thereby a) invigorate plant growth, and b) stimulate root growth<br><br>S: 1) remains to be determined, 2) some experimental evidence; see marsh management<br><br>MARSH SOILS: Persistence MA: Emulating some historic (often natural) condition fosters the production, retention and accumulation of sediments within the managed area, thereby slowing, stopping or reversing marsh losses<br><br>S: Theoretically correct, intuitively appealing but magnitude of response seldom demonstrated, nearly always presumptive, extension from marsh management<br><br>S: see marsh management<br><br>Species Assemblages MA: 1) emulating some historic (often natural) condition is preferred, but 2) the judicious manipulations of primarily depth of flooding, flooding frequency and salinity regimes can be used to perpetuate/expand existing marsh or adjust/amend species assemblages<br><br>S: 1) intuitively appealing 2) see marsh management<br><br>Production See **PRIMARY PRODUCTION** |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **EMERGENT VEGETATION ON EXPOSABLE, ERODED SOILS**<br><br>Of general interest and particular interest to managers intent upon forestalling marsh loss and improving habitat for some species targeted for management; evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>HYDROLOGY: Flooding Frequency<br><br>MARSH SOILS: Surface Elevation<br><br>MARSH SOILS: Water Depth:<br><br>HYDROLOGY: Water Depth<br><br>HYDROLOGY: Sediments<br><br>MARSH SOILS: Composition<br><br>MARSH SOILS: Persistence | HYDROLOGY: Flooding Frequency MA: Only in some cases, typically reflective of project purposes, are periodic eliminations of flooding required; monitored<br><br>S- Conclusively demonstrated<br><br>MARSH/MARSH POND SOILS: Surface Elevation/Water Depth MA- when the opportunity exists, both the periodic, sustained reductions of water depth in the 1) marsh soil profile and 2) periodic, sustained expose of marsh pond soils should be considered because they create growth conditions that support the establishment of plants that otherwise could not exist; 3) water levels can be lowered to promote vegetative growth<br><br>S: Convincingly demonstrated when sustained reduction is achieved<br><br>HYDROLOGY: Water Depth MA: 1) water levels can be raised slowly so as not to stress/kill the plants growing on exposed pond soils; 2) only in some cases is it necessary or prudent to repetitively reduce soil water levels/expose marsh substrates to amend soil chemistry and thereby a) invigorate plant growth, and b) stimulate root growth<br><br>S: 1) conclusively demonstrated, 2) some experimental evidence<br><br>HYDROLOGY: Sediments MA- Vegetation 1) aids in retaining sediments, 2) can respond to sediment depositions; not typically subject to monitoring<br><br>S- 1) Conclusively demonstrated, 2) some experimental evidence<br><br>MARSH SOILS: Composition MA: and S: see **EMERGENT VEGETATION ON UNERODED NATIVE SOILS**<br><br>MARSH SOILS: Persistence MA: 1) induced emergent vegetation functions very much like native emergent vegetation, 2) therein constituting a slowing, stopping or reversal of marsh erosion<br><br>S: 1) intuitively appealing but similarities largely inferred, 2) intuitively appealing but remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects | HYDROLOGY: Flooding Frequency MA- 1) emulating some historic (often natural) condition is preferred; 2) see marsh management<br><br>S- 1) intuitively appealing, 2) see marsh management<br><br>MARSH/MARSH POND SOILS: Surface Elevation/Water Depth MA- 1) emulating some historic (often natural) condition is preferred, 2) in some cases, see marsh management<br><br>S: 1) Intuitively appealing and an extension of marsh management efforts, 2) see marsh management<br><br>HYDROLOGY: Water Depth MA- 1) emulating some historic (often natural) condition is preferred, 2) in some cases, see marsh management<br><br>S: 1) Intuitively appealing and an extension of marsh management efforts, 2) see marsh management<br><br>HYDROLOGY: Sediments MA- 1) emulating some historic (often natural) condition is preferred, 2) in some cases, see marsh management<br><br>S- 1) intuitively appealing, 2) some experimental evidence, 3) evidenced in project designs<br><br>MARSH SOILS: Composition MA- 1) perpetuating the current situation is preferred, 2) only in a few cases may it be necessary or desirable to undertake actions that could result in modifying the soil composition<br><br>S- Intuitively appealing, see also marsh management<br><br>MARSH SOILS: Persistence MA- Applicable only to a few areas<br><br>S: See marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| EMERGENT VEGETATION ON EXPOSABLE, ERODED SOILS (Continued)<br><br>Species Assemblages<br><br>HYDROLOGY: Velocity<br><br>Production<br><br>See Also<br><br>**Primary Production** | Species Assemblages MA: Judicious and repetitive manipulations of depth and duration/frequency of flooding and often salinity regimes are required to 1) perpetuate and/or 2) expand the coverage of created assemblages; rate of expansion typically subject to monitoring<br><br>S: 1) intuitively correct, 2) inconclusively demonstrated, included as a feature/purpose of more recent permit requests<br><br>HYDROLOGY: Velocity MA- vegetation 1) slows surface water velocities, 2) disperses wave energy, thereby reducing erosion rates, and 3) indirectly can be stressed/die from excessive velocities that erode marsh soils and expose roots<br><br>S: 1) & 2) common knowledge, 3) intuitively correct, seldom demonstrated directly<br><br>Production see **PRIMARY PRODUCTION** | Species Assemblages MA: 1) emulating some historic (often natural) condition is preferred, but 2) see marsh management<br><br>S: 1) intuitively appealing 2) see marsh management<br><br>HYDROLOGY: Velocity MA- vegetation 1) slows surface water velocities, 2) disperse wave energy, thereby reducing erosion rates, and 3) indirectly can be stressed/die from excessive velocities that erode marsh soils and expose<br><br>S: see marsh management<br><br>Production see **PRIMARY PRODUCTION** |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **MARSH PONDS/OPEN WATER AREAS**<br><br>Of interest to managers intent upon forestalling marsh loss (primary) and/or improving habitat for species targeted for management (secondary); evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>Size<br><br>Depth<br><br>Interspersion<br><br>Persistence | Size MA: 1) smaller ponds are preferred, 2) lowering pond water levels can be an effective, temporary measure to reduce pond size with longer-term potentialities; typically subject to monitoring<br><br>S: Intuitively correct, see Persistence below and also **WILDLIFE**, typically not subjected to monitoring<br><br>Depth MA: 1) shallower ponds are preferred, 2) lowering pond water levels is an immediately effective way to reduce pond depth with longer-term potentialities; typically subject to monitoring<br><br>S: Intuitively correct, see Persistence below and also **WILDLIFE**<br><br>Interspersion (open water/marsh ratio) MA: Marshes with some, preferably small ponds/open water areas, are more desirable than expanses of unbroken marsh; in some cases subject to monitoring<br><br>S: Inconclusive, most often argued/inferred relative to other management interests (e.g., **WILDLIFE**), and Persistence<br><br>Persistence MA: shallower, smaller ponds/open water bodies are less susceptible to the action of erosive forces; typically subject to monitoring<br><br>S: Intuitively correct, often inferred from photographs, local/professional knowledge and/or anecdotal evidence....pond/open water depth and size, soil type and wind speed and direction appear to be influential but the exact relationship between pond/open water area sizes and water depths and edge erosion rates isn't known | Size MA: 1) emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to affect pond size, but 2) lowering pond water levels can be an effective, temporary measure to reduce pond size with longer-term potentialities<br><br>S: Intuitively correct. Role in affecting pond erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight<br><br>Depth MA: 1) emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to affect pond depth, but 2) lowering pond water levels is an immediately effective way to reduce pond depth with longer-term potentialities<br><br>S: Intuitively correct. Role in affecting pond erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight<br><br>Interspersion (open water/marsh ratio) MA: Emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to stabilize existing ponds<br><br>S: Intuitively correct. Role in affecting erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight<br><br>Persistence MA: shallower, smaller ponds/open water bodies are less susceptible to the action of erosive forces, but emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to stabilize existing ponds<br><br>S: Intuitively correct. Role in affecting erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| SUBMERGED/ FLOATING AQUATIC VEGETATION<br><br>Of interest to managers intent upon improving habitat for species targeted for management (primary) and/or forestalling marsh loss (secondary); evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>HYDROLOGY: Salinity<br>Affects species composition, growth rates, reproduction; potentially stressful, toxic<br><br>Temperature<br><br>Persistence<br><br>HYDROLOGY: Water depth<br><br>Temperature/ HYDROLOGY: Water depth<br>Increasing depths elevate potential for wave damage; extremely shallow depths increase potential temperature-induced biochemical stresses reducing growth or death from desiccation; some attributes subject to monitoring | HYDROLOGY: Salinity MA: 1) each species has a unique salinity tolerance; 2) bases upon those known tolerance, efforts can be undertaken to suppress rapid salinity fluctuations and/or prolonged periods of elevated salinity to invigorate/avoid stressing/killing SAV, 3) salinity thresholds are an effective tool; typically subjected to monitoring<br><br>S: 1) and 2) conclusively demonstrated, 2) intuitively correct, but degree of success seemingly positively correlated with intensity/accuracy of monitoring coupled with correspondingly frequent structure adjustments<br><br>Temperature MA: Excessively high or low water temperatures can be stressful/lethal to aquatic vegetation<br><br>MA: Convincingly demonstrated<br><br>Persistence MA: Dictated by the interaction of temperature, salinity and water depth<br><br>MA: Convincingly demonstrated, and sometimes only basis for selecting, locating and operating water control structures (see WATERFOWL, FISH, SHRIMP and CRABS)<br><br>HYDROLOGY: Water depth MA: 1) exposure of pond soils for about six weeks during the spring growing season stimulates the growth of emergent as well as submerged aquatic plant species; 2) in intermediate, brackish and sometimes low saline marshes, stable water depths during late summer through early fall (early August through mid to late October) can create conditions conducive to a second growth of submerged aquatics; 3) expose of submerged aquatics to the atmosphere for more than a few hours can be lethal<br><br>S: 1 - 3) conclusively demonstrated<br><br>Temperature/HYDROLOGY: Water depth MA: 1) seasonally high water temperatures can be stressful/lethal, 2) deeper water depths take longer to heat up/cool down, and 3) introduction of cooler and otherwise compatible waters can be used to adjust water temperature; water depth typically subject to monitoring<br><br>S: 1) conclusively demonstrated for many species, 2) physical fact, 3) a seldom used option, often because of seasonal salinity-related incompatibilities | HYDROLOGY:<br>Salinity MA: 1) emulating some historic (often natural) condition is preferred, but 2) water level manipulations as described for marsh management are sometimes desirable/necessary<br><br>S: 1) intuitively correct, benefits to submerged aquatic vegetation often indirect result rather than focus of project, 2) see marsh management<br><br>Temperature/ HYDROLOGY: Water depth MA: 1) emulating some historic (often natural) condition is preferred, 2) water diversions can be/are a feature of several projects<br><br>S: Intuitively correct |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SUBMERGED/ FLOATING AQUATIC VEGETATION** (Continued)<br><br>Epiphytic Growth/ HYDROLOGY: Turbidity<br>Prolonged reductions of light intensity can greatly suppress growth, reproduction<br><br>MARSH POND SOILS: Substrate (Consistency/ Composition)<br>possible long-term influence on species composition<br><br>Production/Vigor<br><br>See Also<br><br>**Primary Production** | Epiphytic Growth/HYDROLOGY:Turbidity MA: 1) Algae growth on leaves or turbid waters reduce light needed for photosynthesis, 2) efforts can be taken to reduce pond turbidity; turbidity typically subject to monitoring<br><br>S: 1) Conclusively demonstrated, 2) see immediately below<br><br>MARSH POND SOILS: Substrate (Consistency/ Composition) MA: Pond/open water substrates that are periodically consolidated provide a better root growth environment for some species of SAV; not typically subject to monitoring<br><br>S: 1) conclusively demonstrated, especially for one salt-tolerant species with high food value to waterfowl, 2) apparent from permit data MA: 1) SAV can be invigorated/encouraged to grow on pond/open water substrates that are periodically consolidated through water level reductions, 2) often a prominent feature of a marsh management plan that has a waterfowl component; typically subject to monitoring<br><br>Production/Vigor MA: 1) can be invigorated/encouraged to grow on pond/open water substrates that are periodically consolidated through water level reduction; 2) often a prominent feature of a marsh management plan that has a waterfowl component<br><br>S: 1) conclusively demonstrated, especially for Ruppia, 2) apparent from permit data | Epiphytic Growth/ HYDROLOGY: Turbidity MA: 1) Algae growth on leaves or turbid waters reduce light needed for photosynthesis, 2) efforts can be taken to reduce pond turbidity; turbidity typically subject to monitoring<br><br>S: 1) Conclusively demonstrated, 2) see immediately below<br><br>MARSH POND SOILS: Substrate (Consistency/ Composition) MA: 1) emulating some historic (often natural) condition is preferred, but 2) water level manipulations as described for marsh management are sometimes desirable/necessary<br><br>S: 1) intuitively correct, benefits to submerged aquatic vegetation probably indirect result rather than focus of project, 2) expect for projects that include reductions of pond water levels (see marsh management)<br><br>Production/Vigor MA: 1) emulating some historic (often natural) condition is preferred, but 2) water level manipulations as described for marsh management are sometimes desirable/necessary<br><br>S: 1) intuitively correct, submerged aquatic vegetation more often indirect beneficiary rather than focus of project, 2) expect for projects that include reductions of pond water levels (see marsh management) |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **MARSH POND SOILS**<br><br>Of interest to managers intent upon improving habitat for species targeted for management (often primary) and/or forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review; not subject to monitoring<br><br>Important Attributes<br><br><u>Surface Elevation</u><br><br><u>Water Depth</u><br><br><u>Persistence</u> | <u>Surface Elevation</u> MA: When manipulating water depths over and within some of the marsh pond soil profile is called for, it can 1) create soil growth conditions conducive to inducing /invigorating the growth of submerged aquatic vegetation and possibly inducing the growth of emergent marsh grasses, especially along ponds edges, thus 2) contributing to slowing, stopping or reversing the erosion of marshes; not typically subject to monitoring<br><br>S: 1) Conclusively documented, 2) intuitively correct but magnitude of contribution seldom demonstrated, largely presumptive, sometimes monitored<br><br><u>Persistence</u> MA: Seasonally adjusting, including in some cases planned, periodic reductions of marsh pond soil profile water levels, or simply diminishing the variation in depth of water in ponds, contributes to 1) slowing or halting losses of pond soils, 2) perpetuates the retention by ponds of mobilized marsh soils, thereby, 3) aiding in slowing marsh erosion; not typically subject to monitoring<br><br>S: Intuitively correct but magnitude of contribution seldom demonstrated, nearly always presumptive | <u>Surface elevation</u> MA: 1) emulating some historic (often natural) condition is preferred, but 2) water level manipulations as described for marsh management are sometimes desirable/necessary<br><br>S: 1) intuitively correct, 2) role in affecting erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight<br><br><u>Persistence</u> MA: 1) shallower, smaller ponds/open water bodies are less susceptible to the action of erosive forces, 2) but emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to stabilize marsh pond soils<br><br>S: Intuitively correct. Role in affecting erosion rates largely derived/inferred from photographs, measurements/anecdotal observations of marsh management efforts, and professional insight<br><br>S: 1) Intuitively correct- role in affecting pond soil erosion rates largely derived/inferred photographs, measurements/anecdotal observations of marsh management efforts, and professional insight, typically not subject to monitoring; 2) see marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **MARSH POND SOILS** (Continued)<br><br>Composition/ Consistency<br><br>Microorganisms/ Benthos | Composition/Consistency MA: 1) soils with too much unconsolidated organic matter can be made less erosive; not typically subject to monitoring; 2) inclusion of multiple soil types within a single managed area often dictated by other actors, probably not of consequence<br><br>S: 1) conclusively demonstrated relative to the effects of water level reductions on consolidating/firming pond/open water soils and the consequent improved potential to invigorate/induce the growth of submerged aquatic vegetation; 2) apparently presumed<br><br>Microorganisms/Benthos MA: species assemblages may change but role in nutrient dynamics/primary production inconsequentially different, if at all<br><br>S: Indirect evidence supports assumption, but remains to be conclusively demonstrated | Composition/Consistency MA: emulating some historic (often natural) condition is preferred and often compliments other efforts undertaken to affect ponds, but 2) depending upon oftentimes secondary project purposes, lowering pond water levels can also be an effective, complimentary, temporary measure to reduce pond soil losses with longer-term potentialities<br><br>Microorganisms/Benthos MA: species assemblages may change but role in nutrient dynamics/primary production inconsequentially different, if at all<br><br>S: Indirect evidence supports assumption, but remains to be conclusively demonstrated |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **FISH, SHRIMP and CRABS**<br><br>Never a stand-alone reason for undertaking management, ; evaluated by CORPS and some agencies during project comment period and review; some attributes may be subject to monitoring<br><br>Important Attributes<br><br>Interspersion<br><br>Water Depth<br><br>Salinity<br><br>Water Velocity | Interspersion MA: 1) marshes with some ponds/open water areas are more desirable than expanses of unbroken marsh; 2) ponds with vegetation provide cover from predators, shelter and food;<br><br>S: 1) and 2) intuitively appealing, observed/inferred relative to role of marsh edge/submerged aquatic vegetation in several shrimp and fish life histories; typically subject to monitoring<br><br>Water Depth MA: Many species exhibit daily movements between tidal ponds and tidal creeks and the vegetated marsh surface within a given marsh as a function of water depth to forage and for cover<br><br>S: Convincingly demonstrated<br><br>Salinity MA: Naturally occurring seasonal salinity variations are accompanied by the exodus as well as the entrance of different collections of dependent/associated species from the same marsh, from/between different marsh types, to/from/between marshes and bays and the open sea<br><br>S: Convincingly demonstrated<br><br>Water Velocity MA: 1) the direction and depth of penetration into marshes of some species, especially of immature stages, is often strongly related to the direction and velocity of moving water; 2) the timely movement of some species from the marsh and ponds to larger water bodies as part of their migratory movements may be assisted by rapid water movements associated with weather events/frontal passage<br><br>S: 1) and 2) Convincingly demonstrated<br><br>some attributes, a valid assumption for others, but generally remains to be determined whether other potential differences are significant and whether such differences are categorical or related to individual projects | Interspersion MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be much less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) and 2) theoretically correct, intuitively appealing but presumptive - remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects; 3) see marsh management<br><br>Water Depth MA: and S: see above<br><br>Salinity MA: and S: see above<br><br>Water Velocity MA: and S: see above |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| FISH, SHRIMP and CRABS (Continued)<br><br>Interspersion, Flooding Frequency/Water Depth, Salinity<br><br>*SEE ALSO*<br><br>SUBMERGED/ FLOATING AQUATIC VEGETATION<br><br>EMERGENT VEGETATION ON UNERODED NATIVE SOILS<br><br>EMERGENT VEGETATION ON EXPOSABLE ERODED SOILS<br><br>WILDLIFE<br><br>HYDROLOGY: Salinity<br><br>HYDROLOGY: Water<br><br>SECONDARY PRODUCTION<br><br>SOCIO-ECONOMICS | Interspersion, Flooding Frequency/Water Depth, Salinity MA: Structures or management efforts that have the effect of seasonally stabilizing water levels near, at or above the marsh soil surface, lowering and stabilizing soil profile water levels below the marsh soil surface for a portion of the growing season in some years {especially in intermediate and brackish (and in a few cases saline marsh)} types, and/or limiting/suppressing salinity levels, represent prudent and often necessary departures from ambient conditions to: 1) stimulate the production of emergent and aquatic vegetation; 2) reduce erosion; 3) can be undertaken without unduly affecting fish, shrimp and crabs; 4) a- any adverse effects can be minimized, b- any unavoidable adverse effects come close to or are more than likely offset/superseded by benefits derived from reduced erosion, increased primary production and/or increased secondary production<br><br>S: 1) convincingly demonstrated for submerged aquatics, for emergent vegetation it remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 2) probably true in short-term but long-term differences are less definitive because of the apparent inability to predictably achieve successful draw-downs; 3) appears be an invalid assumption for any species whose life cycle cannot be completed within the managed area; 4)a- a valid assumption but accommodations often limited to those that won't compromise the goals/purpose of the project; 3)b- assumption remains to be verified as to whether any differences are significant and whether such differences are categorical or related to individual projects | Interspersion, Flooding Frequency/Water Depth, Salinity MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be much less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) and 2) theoretically correct, intuitively appealing but presumptive - remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects; 3) see marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **WILDLIFE**<br><br>Improving habitat/numbers of some species often a stand-alone reason for undertaking management; evaluated by CORPS and some agencies during project comment period and review; some attributes may be subject to monitoring<br><br>Important Attributes<br><br>REPTILES<br><br>AMPHIBIANS<br><br>BIRDS<br><br>MAMMALS | REPTILES/AMPHIBIANS<br><br>MA: Except for the alligator (see furbearers), 1) not targeted for management; 2) as a group, presumed indirect beneficiaries from- a) habitat protection (e.g., salinity and water level control/reduction) for targeted species, b) marsh loss reduction or c) if management effort causes shift to fresher marsh type<br><br>S: 1) Often cited as secondary (or characterized as unintended) benefit of management (by deduction from species life requisite requirements); 2) intuitively correct (especially if marsh shifts from brackish to intermediate or fresh marsh type), but generally remains to be quantified<br><br>BIRDS<br><br>MA: Except for waterfowl (see below), 1) not targeted for management; 2) as a group, presumed to be indirect beneficiary of a) marsh erosion control efforts/habitat protection for targeted species, b) marsh loss reduction, c) presence of and vegetation associated with dredged material embankments<br><br>S: 1) Often cited as secondary (or characterized as unintended) benefit of management (by deduction from species life requisite requirements); 2) intuitively correct (especially if marsh shifts from brackish to intermediate or fresh marsh type), but generally remains to be quantified<br><br>MAMMALS<br><br>MA- Except for furbearers (see below), 1) not targeted for management; 2) as a group, presumed to be indirect beneficiary of a) marsh erosion control efforts/habitat protection for targeted species, b) marsh loss reduction, c) presence of and vegetation associated with dredged material embankments<br><br>S: 1) Often cited as secondary (or characterized as unintended) benefit of management (by deduction from species life requisite requirements); 2) intuitively correct (especially if marsh shifts from brackish to intermediate or fresh marsh type), but generally remains to be quantified | REPTILES/AMPHIBIANS<br><br>MA: Except for alligator, see marsh management<br><br>S: See marsh management; remains to be determined if significantly different from marsh management<br><br>BIRDS<br><br>MA: Except for waterfowl, see marsh management<br><br>S: See marsh management, remains to be determined if significantly different from marsh management<br><br>MAMMALS<br><br>MA- Except for furbearers, see marsh management<br><br>S: See marsh management, remains to be determined if significantly different from marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **WILDLIFE** (Continued)<br><br>FURBEARERS<br><br>*Salinity<br><br>*Pond/Water Depth<br>* *Pond:/marsh ratio; interspersion<br>* Pond plants<br><br>* Native emergent vegetation<br><br>* Induce emergent vegetation | FURBEARERS<br><br>Alligators<br><br>MA: High quality conditions exist in fresh, intermediate or brackish marsh that encompass or are managed to foster/create: 1) both shallow and deep (e.g., canals, bayous) open water all year long (for breeding and overwinter cover); 2) dense vegetation or embankments (nest sites); 3) maximum salinities do not/exceed 10 ppt; 4) water level reductions don't occur before mid-May; and, 5) water levels during June-August (nesting season) should be suppressed to avoid flooding of nests<br><br>S: 1) - 5) Conclusively demonstrated; 3) structures are used to affect salinity controls; 4) repetitive water level reductions during late winter to early summer would appear to be counter-productive, at least in the short-term<br><br>Other furbearers (e.g., nutria, muskrat): Almost never has been a stipulated reason to undertake management<br><br>MA: As a group, presumed indirect beneficiaries from- a) habitat protection (e.g., salinity and water level control/reduction) for targeted marsh plant and/or animal species, b) marsh loss reduction, or c) if management effort causes shift to fresher marsh type<br><br>S: Often cited as secondary (or characterized as unintended) benefit of management (by deduction from species life requisite requirements); intuitively correct (especially if marsh shifts from brackish to intermediate or fresh marsh type), but generally remains to be quantified | FURBEARERS<br><br>Alligators<br><br>MA: In fresh and intermediate marshes 1) emulating some historic (often natural) condition is preferred, probably reduced to a companion reason for undertaking management where such an approach is not possible; 2) imposition of water level control may be necessary/prudent in all marsh types during the nesting season; 3) imposition of salinity controls may be necessary/prudent, especially in more brackish marshes; 4) habitat quality diminishes greatly in those exceptional situations where is it necessary or prudent to repetitively reduce soil water levels<br><br>S: 1) - 4) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Other furbearers (e.g., nutria, muskrat):<br><br>MA: and S: See marsh management, remains to be determined whether potential differences are significant and whether such differences are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **WILDLIFE** (Continued)<br><br>Waterfowl<br><br>* Pond/water depth<br><br>* Pond:/marsh ratio; size; interspersion<br><br>* Pond/water plants<br><br>* Native and Induced vegetation<br><br>Production<br><br>*SEE ALSO*<br><br>AQUATIC VEGETATION<br><br>FISH, SHRIMP and CRABS<br><br>PRIMARY PRODUCTION<br><br>SECONDARY PRODUCTION<br><br>SOCIO-ECONOMICS | WATERFOWL<br><br>Pond/Water depth MA: areas where water depths are maintained at 12 to 18 inches from late-fall to early spring are highly attractive to waterfowl as areas to rest/possibly feed<br><br>S: Conclusively demonstrated<br><br>Pond:marsh ratio/interspersion: MA 1) The several migratory waterfowl species prefer different pond sizes; 2) fewer waterfowl tend to associate with marshes with too little or too much open water, 3) interspersion can be adjusted to accommodate species that require more or less open water than in the targeted marsh landscape<br><br>S: Convincingly demonstrated<br><br>Pond/water plants MA: invigorating/initiating the growth of submerged vegetation 1) improves overwintering habitat quality, 2) making the area more attractive to waterfowl<br><br>S: Convincingly demonstrated<br><br>Native and Induced vegetation MA: Enhances food value of habitat, especially induced annual vegetation that is<br><br>S: Demonstrated<br><br>Production MA: 1) native mottled duck is benefitted from a- stabilized water levels (reduced nest flooding), b- reduced surface water salinities (stressful to ducklings); 2) migratory species in better condition to breed<br><br>MA: 1) conclusively demonstrated; 2) intuitively appealing but function of amount and quality of habitat of all coastal marshes | WATERFOWL<br><br>Pond depth MA: areas where water depths are maintained at 12 to 18 inches from late-fall to early spring are highly attractive to waterfowl as areas to rest/possibly feed<br><br>S: Conclusively demonstrated<br><br>Pond:marsh ratio/interspersion MA: 1) the several migratory waterfowl species prefer different pond sizes; 2) fewer waterfowl tend to associate with marshes with too little or too much open water, 3) interspersion mostly likely cannot be adjusted to accommodate species that require more or less open water than in the targeted marsh landscape<br><br>S: 1) and 2) convincingly demonstrated; 3) intuitively correct<br><br>Native and Induced vegetation MA: Except for projects that involve water level reductions, benefits generally lower than what is derived from marsh management and limited to emergent vegetation<br><br>S: Remains to be determined whether potential differences are significant and whether such differences are categorical or related to individual projects<br><br>Production MA: see Native and Induced Vegetation above |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SUBSURFACE GEOLOGY**<br><br>Typically of little or no direct interest to managers; evaluated by CORPS and some agencies during project comment period and review; not subject to monitoring<br><br>Important Attributes<br><br>Faults<br><br>Settlement Potential | Faults MA: 1) interior losses due to fault activity will continue; 2) minor factor; 3) can be partially addressed indirectly through enhanced sediment retention and enhanced organic matter production and retention<br><br>S: MA 1) a certainty; 2) inconclusive; 3) inconclusive - see organic matter, sediment retention and persistence; not subject to monitoring<br><br>Settlement Potential MA: 1) reason for losses to continue nearer Gulf; 2) can be partially addressed indirectly through enhanced sediment retention and enhanced organic matter production and retention<br><br>S: 1) generally confirmed for different soils; 2) inconclusive - see organic matter, sediment retention and persistence; not subject to monitoring | Faults MA: emulating some historic, often natural, condition is preferred<br><br>S: Inconclusive - available data insufficient to confirm or refute, mostly extension of marsh management<br><br>Settlement Potential MA: emulating some historic, often natural, condition is preferred<br><br>S: Inconclusive - available data insufficient to confirm or refute, mostly extension of marsh management |
| **SURFACE GEOMOR-PHOLOGY**<br><br>Typically seen as part of problem, managers see potential for solution; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br>Dredged Material Embankments/Water Control Structures | Dredged Material Embankments/Water Control Structures MA: 1) Construction of new ones, rehabilitation of deteriorated ones and/or the maintenance of existing ones are very often absolutely essential to achieving the stipulated purpose(s) of projects; 2) derived long-term benefits outweigh short-term damages<br><br>S: 1) Correct relative to some management purposes; 2) presumed, remains to be convincingly demonstrated | Dredged Material Embankments/Water Control Structures MA: 1) emulating natural hydrology is preferred; 2) construction of new ones, rehabilitation of deteriorated ones and/or the maintenance of existing ones are sometimes required at strategic locations to achieve the stipulated purpose(s) of some projects; 3) derived long-term benefits outweigh short-term damages<br><br>S: 1 and 2) - intuitively correct, apparently an innovative application of as yet unpublished lessons learned from marsh management; 3) available data insufficient to confirm or refute |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **HYDROLOGY: Water**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>**Important Attributes**<br><br>Origin<br><br>Flooding Frequency<br><br>Flooding Duration<br><br>Depth<br><br>Velocity<br><br>Dredged Material Embankments/ Water Control Structures<br><br>*See Also*<br><br>**SURFACE GEOMOR-PHOLOGY**<br><br>**FISH, SHRIMP and CRABS**<br><br>**WILDLIFE**<br><br>**PRIMARY PRODUCTION**<br><br>**SECONDARY PRODUCTION**<br><br>**SOCIO-ECONOMICS** | Origin MA: 1) increasing Gulf influence (sea level rise) will continue to be destructive; 2) can/must be overridden<br><br>S: MA 1) generally confirmed, 2) inconclusive; not typically subject to monitoring<br><br>Flooding Frequency MA: limiting to periodic exclusion of natural conditions is often necessary; monitored through water levels<br><br>S: Inconclusive, depends upon project purposes; not typically subject to monitoring<br><br>Flooding Duration MA: general reduction &/or periodic, short-term elimination is beneficial, often essential; generally subject to monitoring<br><br>S: Inconclusive, depends upon project purpose<br><br>Depth MA: 1) periodic, repetitive reduction in soil profile/exposure of pond substrates is often essential, generally beneficial; 2) water levels that rise to heights that overtop the features controlling hydrology tend to erase any induced differences that may have arisen between managed and unmanged areas<br><br>S: 1) inconclusive, and largely dependent upon project purpose; 2) intuitively correct, at least in the short-term, could be an unavoidable cyclic phenomenon induced by management<br><br>Velocity MA: Reduction may not be essential, but is often beneficial; not typically subject to monitoring<br><br>S: Inconclusive, often inferred<br><br>Dredged Material Embankments/Water Control Structures MA: any adverse effects 1) are probably inconsequential, 2) often offset/superseded by the success of the project<br><br>S: 1) inconclusive, appear to be underestimated relative to some significant resources, 2) inconclusive, appear to overestimated in some cases relative to some significant resources | Origin MA: emulating some historic, often natural, condition is preferred<br><br>S: Inconclusive - available data insufficient to confirm or refute, mostly extension of marsh management<br><br>Flooding Frequency MA: emulating some historic, often natural, condition is preferred<br><br>S: Inconclusive - available data insufficient to confirm or refute, great reliance upon marsh management results<br><br>Flooding Duration MA: Reduction not always required, can be beneficial, depends upon specific situation<br><br>S: Inconclusive - available data insufficient to confirm or refute, great reliance upon marsh management results<br><br>Water Depth MA: Emulating some historic, often natural, condition is preferred<br><br>S: Inconclusive - available data insufficient to confirm or refute, mostly refined extension research, experience and marsh management results<br><br>Velocity MA: Reduction may not be essential, but is often beneficial<br><br>S: Great reliance upon research, experience and marsh management results<br><br>**SURFACE GEOMORPHOLOGY**<br>Dredged Material Embankments/ Water Control Structures MA: 1) in most cases their judicious use can a) reduce any adverse effects to minimal levels, b) which are more than likely offset/superseded by benefits derived from the project, but, 2) can in some cases have effects comparable/identical with marsh management<br><br>S: Intuitively appealing, based upon apparently innovative application of as yet undocumented lessons learned from marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **HYDROLOGY: Sediments**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br><u>Origin</u> External and internal<br><br><u>Depth</u> Overtopping water levels<br><br><u>Composition</u> Substitutability of organic and mineral sediments<br><br><u>Penetration/ Delivery</u> What controls the rate/volume of sediments delivered to the managed area<br><br><u>Retention</u> What controls the volume of delivered sediments retained | <u>Origin</u><br>MA: External- exclusion neither intended nor desirable, generally not critical; not subject to monitoring<br><br>S: Inconclusive, but suggests consequences of exclusion may be underestimated<br><br>MA: Internal- plant biomass production can be greatly enhanced, often enough to at least compensate & potentially override any unavoidable exclusions; not typically subject to monitoring<br><br>S: Inconclusive, although plant biomass production can often be periodically increased<br><br><u>Depth</u> MA: Water levels that rise to heights that overtop the features controlling hydrology tend to erase any induced differences that may have arisen between managed and unmanged areas<br><br>S: Intuitively correct at least in the short-term, remains to be definitively determined whether any differences are significant and whether such differences are categorical or related to individual projects, probably an unavoidable cyclic phenomenon induced by some forms of management<br><br><u>Composition</u> MA: 1) Organic sediments may not be identical to mineral sediments, but 2) organic sediments are better than none<br><br>S: 1) Mineral and organic sediments exhibit very different physical, chemical and ecological properties, 2) inconclusive<br><br><u>Penetration/Delivery</u> MA: Consequences of longer-term reduced introductions are largely inconsequential and are probably offset by natural, larger storm events, and retained organic matter; not subject to monitoring<br><br>S: Inconclusive, degree of compensatory role of storms and retained organic matter remains to be determined and if any differences are significant and whether such differences are categorical or related to individual projects<br><br><u>Retention</u> MA: Reduced water velocity encourages greater retention; not typically subject to monitoring<br><br>S: Intuitively valid, remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects | <u>Origin</u><br>MA: External- emulating some historic, often natural, condition is considered optimal, but see also marsh management<br><br>S: Inconclusive, but consequences can, in some cases, resemble those associated with marsh management; remains to be determined if significantly different from marsh management<br><br>MA: Internal- Little to some increase in plant biomass likely in response to reducing stressful conditions<br><br>S: Intuitively valid but undocumented; remains to be determined if significantly different from marsh management<br><br><u>Depth</u> MA: 1) emulating some historic (often natural) condition is preferred, 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages;<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br><u>Composition</u> MA: Far less disruption of balance between mineral and organic sediment inputs than marsh management<br><br>S: Intuitively valid in many cases, but undocumented and can differ greatly depending upon project design; remains to be determined if significantly different from marsh management<br><br><u>Penetration/Delivery</u> MA: and S: See <u>Composition</u><br><br><u>Retention</u> MA: and S: See <u>Composition</u> |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **HYDROLOGY: Sediments** (Continued) | | |
| Internal Distribution/ Settlement Patterns What controls where the retained sediments are deposited | Internal Distribution/Settlement Patterns MA: Areas where sediments are needed are benefitted; typically subject to monitoring<br><br>S: Inconclusive, although some sediments are mobile and subject to periodic redistribution | Internal Distribution/Settlement Patterns MA: and S: See Composition |
| Marsh Microorganisms/ Phytoplankton | Marsh Microorganisms/ Phytoplankton MA: Elevated turbidity levels inhibit activity/contribution to primary productivity<br><br>S: Convincingly demonstrated, but apparently not always essential in well mixed system | Marsh Microorganisms/ Phytoplankton MA: see marsh management<br><br>S: see marsh management, remains to be determined if significantly different from marsh management |
| Nutrients | Nutrients MA: Although: 1) several nutrients are transported adhered to mineral soil particles, 2) remobilization and retention of sediments and 3) sediments introduced/delivered by strom tides offset any adverse differences induced by management<br><br>S: 1) convincingly demonstrated; 2) and 3) remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects | Nutrients MA: see marsh management<br><br>S: see marsh management, remains to be determined if significantly different from marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **HYDROLOGY: Salinity**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br>Concentration<br>* Average - Characterizes marsh types, used in formulating management protocols<br><br>* Maximum- Relative to marsh type can be stressful or lethal<br><br>Duration Relative to marsh type, prolonged exposure can be stressful or lethal<br><br>Depth Elevating soil water salinities can be stressful or lethal<br><br>*SEE ALSO*<br><br>**FISH, SHRIMP and CRABS**<br><br>**WILDLIFE**<br><br>**PRIMARY PRODUCTION**<br><br>**SECONDARY PRODUCTION** | Concentration<br>* Average: MA- where reductions are generally possible 1) they are very often worth attempting, 2) in many cases essential to achieve project purposes; typically subject to monitoring<br><br>S- Degree of success generally site or project specific, available freshwater for dilution and/or adjustment of structures almost daily correlated with higher potential for success<br><br>* Maximum: MA- Maximum should be below levels toxic to more sensitive plant community members; typically subject to monitoring<br><br>S- Intuitively valid...use of salinity thresholds promising in some cases, available freshwater for dilution and/or adjustment of structures almost daily correlated with higher potentials for success, remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Duration MA: Depending upon the affected marsh plant community type, even average salinity conditions can become potentially harmful during droughts, or after storms if not evacuated; typically subject to monitoring<br><br>S: Clear evidence that surface water salinity and/or rising soil water salinity can be stressful or toxic<br><br>Depth MA: Depending upon the affected marsh plant community type- 1) soil water salinities in the root zone can become potentially stressful/lethal, 2) water level reductions accompanied by flushing with fresher water is an effective control measure; not typically subject to monitoring<br><br>S: 1) Conclusive demonstrated, 2) intuitively correct, anecdotal evidence | Concentration MA- Emulating some historic, often natural, condition is preferred, in a limited number of cases desirable or essential depending upon project purpose<br><br>S- Mostly based on marsh management results; remains to be determined if significantly different from marsh management<br><br>Duration MA: Emulating some historic, often natural, condition- 1) reduces/minimizes potential for adverse consequences, 2) thereby a- invigorating plant growth, and b- stimulating root growth<br><br>S: Inconclusive, often inferred based on marsh management results; remains to be determined if significantly different from marsh management<br><br>Depth MA: Emulating some historic, often natural, condition- 1) reduces/minimizes potential for adverse consequences, 2) thereby a- invigorating plant growth, and b- stimulating root growth<br><br>S: Inconclusive, often inferred based on marsh management results; remains to be determined if significantly different from marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **HAZARDOUS, TOXIC & RADIOACTIVE WASTES**<br><br>Never has been a stipulated reason to manage; careless construction/ maintenance could have site-specific implications; evaluated by CORPS and some other Federal agencies during project comment period and review<br><br>Important Attributes<br><br>Examples-<br><br><u>Heavy Metals</u><br><br><u>Petroleum/Mineral Extraction Wastes/Discharges</u><br><br><u>Pesticide Residues</u> | MA: Substance(s) of concern usually stressful/toxic to animal forms; possibility for bioacumulation<br><br>S: Procedures exist to identify/resolve issues related to hazardous, toxic and radioactive resources on a case-by-case basis | MA: See marsh management<br><br>S: See marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **MARSH MICRO-ORGANISMS**<br><br>Never has been a reason to undertake management; involved in nutrient dynamics, break-down rates of organic matter (see also Emergent and Aquatic Vegetation significant resource headings); in the absence of oxygen, sulphur driven species/processes apparently become quite prominent in break-down processes; evaluated by CORPS during project comment period and review; not subject to monitoring<br><br>Important Attributes<br><br>Bacteria/ Fungi/Viruses<br><br>Dissolved Oxygen/ Turbidity<br><br>Temperature<br><br>Particle size<br><br>Flooding Duration/ Depth of Flooding | Bacteria/Fungi/Viruses There response to management is likely to differ between projects and could have cumulative implications<br><br>Dissolved Oxygen/Turbidity MA: 1) dissolved oxygen levels influence the species composition of the marsh microbial community; 2) elevated turbidity levels can suppress photosynthetic activity which can reduce dissolved oxygen levels; 3) reducing turbidity levels in slow water velocity areas to appreciably increase photosynthetic activity is one way to increase dissolved oxygen; 4) higher dissolved oxygen levels facilitate the activity of marsh microorganisms that use oxygen and the processes they mediate<br><br>S: Intuitively correct; evidence is convincing from laboratory studies and strongly suggestive from field studies<br><br>Temperature/Particle size MA: 1) During the warmer months oxygen mediated break-down/nutrient processes are expected to be more prominent and can be expected to occur faster than in cooler periods; 2) smaller particle sizes are broken down faster due to greater surface areas exposed to microbial activity; 3) smaller particle sizes are decomposed faster than larger particle sizes at the same temperature<br><br>S: Evidence is convincing from laboratory studies and a corresponding causal relationship is apparent from field studies<br><br>Flooding Duration/Depth of Flooding MA: 1) Reducing water levels within soil profiles, as well as stabilizing water levels near, at or above soil surfaces, changes the oxygen dynamics throughout the entire marsh/pond soil profile; 2) reducing/suppressing daily/monthly/seasonal water level variations probably induces changes in the microbial community and possibly the functions and process they mediate; 3) the short-term and long-term consequences should not/cannot be presumed to be beneficial/neutral/adverse until characterized<br><br>S: 1) evidence is convincing from laboratory studies and strongly suggestive from field studies; 2) intuitively correct; 3) see PRIMARY PRODUCTION | Bacteria/Fungi/Viruses There response to management is likely to differ between projects and could have cumulative implications<br><br>Dissolved Oxygen/Turbidity MA: 1) emulating some historic (often natural) condition is preferred, 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br>Temperature MA: and S: see Dissolved Oxygen/Turbidity<br><br>Particle size MA: and S: see Dissolved Oxygen/Turbidity<br><br>Flooding Duration/Depth of Flooding MA: and S: see Dissolved Oxygen/Turbidity |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| MARSH MICRO-ORGANISMS (Continued)<br><br>Salinity<br><br>*See Also*<br><br>SECONDARY PRODUCTION<br><br>HYDROLOGY: Water<br><br>PRIMARY PRODUCTION | Salinity MA: An indirect influence on microbial community structure and process rates because: 1) salinity influences plant assemblages; 2) different plants decompose faster than others; and 3) different parts of the same plant can decompose faster than other parts<br><br>S: Evidence is convincing from laboratory studies and strongly suggestive from field studies | Salinity MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should be less<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **PHYTO-PLANKTON**<br><br>Never has been a reason to undertake management; involved in organic matter processing, nutrient dynamics, contribute to primary production, and are themselves a major food source for zooplankton and plankton-eating organism; evaluated by CORPS during project comment period and review; not subject to monitoring<br><br>Important Attributes<br><br>Dissolved Oxygen/ Turbidity<br><br>Nutrients<br><br>Temperature<br><br>Flooding Duration/ Depth of Flooding | Dissolved Oxygen/Turbidity MA: & S: see MARSH MICRO-ORGANISMS, same heading<br><br>Temperature MA: 1) species assemblages generally reflect short-term prevailing conditions; 2) management actions that affect daily water temperatures probably would induce greater changes in the phytoplankton community than do actions that may affect monthly or longer-term water temperature regimes; 3) the short-term and long-term consequences should not/cannot be presumed to be beneficial/neutral/adverse until characterized<br><br>S: 1) intuitively correct and a plausible generalization; 2) intuitively correct, apparently remains to be characterized in managed Louisiana areas; 3) see PRIMARY PRODUCTION<br><br>Nutrients MA: 1) carbon, nitrogen, phosphorous and silicon are essential nutrients; 2) any one can be limiting; 3) nitrogen may be limiting more often than the other nutrients; 4) seasonal variations in nutrient concentrations can also be influential; 5) some forms of nitrogen are used more quickly than other; 6) nitrogen is an essential life requisite for many micro-organism;<br><br>S: demonstrated<br><br>Flooding Duration/Depth of Flooding - MA: 1) water level drawdowns intended to expose soils would likely have a dramatically greater effect on phytoplankton community structure and production than would pool stabilizations; 2) the short-term and long-term consequences of such management should not/cannot be presumed to be beneficial/neutral/adverse until characterized<br><br>S: 1) intuitively correct and a plausible generalization from the literature; 2) remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; (see PRIMARY PRODUCTION) | Dissolved Oxygen/Turbidity MA: and S: see marsh management<br><br>Temperature MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br>Nutrients MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br>Flooding Duration/Depth of Flooding MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **PHYTO-PLANKTON** (Continued)<br><br>Zooplanktors/Fish/ Benthos<br><br>*See Also*<br><br>**FISH, SHRIMP and CRABS**<br><br>**PRIMARY PRODUCTION** | Zooplanktors/Fish/Benthos MA: 1) these organisms actively consume phytoplankton, 2) possibly a predator-prey relationship in some cases; 3) the short-term and long-term consequences of management should not/cannot be presumed to be beneficial/neutral/adverse until characterized<br><br>S: 1) conclusively demonstrated; 2) suggestive and other possible relationships could exist; 3) remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects | Zooplanktors/Fish/Benthos MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **NUTRIENTS**<br><br>Never has been a reason to undertake management; reciprocal interdependency between growth and dynamics of microorganisms and plants; evaluated by CORPS during project comment period and review; possible project-level and cumulative implications; not subject to monitoring<br><br>Important Attributes<br><br>Oxygen<br><br>Temperature<br><br>Sulphur - soil concentration is index to duration of flooding, physiological state of plants, toxic in high concentrations<br><br>HYDROLOGY: Salinity<br>Soil and surface water concentrations are index to physiological state of plants, potentially toxic even in relatively low surface water concentrations<br><br>Budgets | Oxygen MA: influences nutrient uptake, processing and availability in the soils and water column through- 1) biologically mediated reactions; ) and 2) chemical reactions; 3) management actions that affect daily oxygen levels probably would induce greater changes than do actions that may affect monthly or longer-term oxygen regimes; 4) the short-term and long-term consequences should not/cannot be presumed to be beneficial/neutral/adverse until characterized<br><br>S: 1) & 2) conclusively demonstrated; 3) intuitively correct but a generalization; 4) apparently remains to be definitively determined whether any differences are significant and whether such differences are categorical or related to individual projects involving managed Louisiana marshes<br><br>Temperature MA: & S: see Oxygen immediately above<br><br>Sulphur/Nitrogen/HYDROLOGY:Salinity MA: 1) in the absence of oxygen and more so in an intermediate to saline marsh, influence nutrient uptake, processing and availability in soils through- 1) biologically mediated reactions (see MARSH MICROORGANISMS, PHYTOPLANKTON); and 2) chemical reactions; 3) management actions that reduce water levels in the soil profile a) oxygenate the environment, thereby inducing fairly rapid reversals in the chemical reactions and facilitate slower changes in the organisms that mediate the biochemical processes, b) allow for faster cleansings of toxic metabolites from the soil profile; 4) the short-term and long-term consequences should not/cannot be presumed to be definitively beneficial/neutral/adverse until characterized; and 5) should be judged in the context of the project purpose and/or the effect on PRIMARY PRODUCTION<br><br>S: 1) - 3) definitively demonstrated; 3) apparently remains to be definitively determined whether any differences are significant and whether such differences are categorical or related to individual projects involving managed Louisiana marshes; 4) relative to project purpose<br><br>Budgets | Oxygen MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br>Temperature MA: & S: see marsh management<br><br>Sulphur/Nitrogen/HYDROLOGY:Salinity MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **NUTRIENTS** (Continued)<br><br>Nitrogen, Phosphorous, Iron Potassium & Silicon Essential for growth<br><br>*See Also*<br><br>MARSH MICRO-ORGANISMS,<br><br>PHYTO PLANKTON<br><br>PRIMARY PRODUCTION | Nitrogen, Phosphorous, Iron, Potassium MA: 1) uptake, form and dynamics strongly mediated by soil and/or water column bacteria and/or algae, and oxygen levels and temperature; 2) in soils lacking an oxygenated layer a) stressful/toxic levels of ammonium can accumulate; and, b) phosphorous associated with clay particles and complexed with iron can be released in a soluble form; 3) management actions that lower and stabilize soil profile water levels and/or stabilize water levels near, at or above the marsh soil surface, especially in intermediate, brackish and saline marsh types, can represent appreciable departures ambient conditions; 4) the short-term and long-term consequences should not/cannot be presumed to be definitively beneficial/neutral/adverse until characterized; and 5) should be judged in the context of the effect on PRIMARY PRODUCTION<br><br>S: 1) - 2) definitively demonstrated; 3) intuitively correct; 4) apparently remains to be definitively determined whether any differences are significant and whether such differences are categorical or related to individual projects involving managed Louisiana marshes; 4) should be judged in the context of the project purpose and/or the effect on PRIMARY PRODUCTION | Nitrogen, Phosphorous, Iron Potassium & Silicon MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **PRIMARY PRODUCTION**<br><br>Never the stipulated reason to manage; usually focuses on the emergent and aquatic vegetation components relative to an interest in forestalling marsh loss and/or waterfowl an wildlife; evaluated by CORPS and some agencies during project comment period and review; some components subject to monitoring; project-specific and cumulative implications<br><br>Important Attributes<br><br><u>Emergent Vegetation</u><br><br><u>Aquatic Vegetation</u> | **PRIMARY PRODUCTION** has four constituent components:<br><br><u>Emergent Vegetation</u> MA: 1) management actions that- a) stabilize water levels, sometimes seasonally, near, at or above the marsh soil surface, b) and/or lower and stabilize soil profile water levels above the marsh soil surface for a portion of the growing season in some years, especially in intermediate, brackish and saline marsh types, represent prudent and often necessary departures from ambient conditions to stimulate the production of emergent vegetation; 2) contributes to primary production; 3) can be undertaken without unduly affecting other system attributes<br><br>S: 1) short-term responses appear to be generally as predicted, but response enhanced if a successful draw-down is achieved, long-term differences are less definitive because of the apparent inability to predictably achieve successful draw-downs; thus 2) when it occurs yes the assumption is valid but cannot yet conclude differences are definitively representative of all undertakings; 3) appears be an invalid assumption for some attributes, a valid assumption for others, but generally remains to be determined whether other potential differences are significant and whether such differences are categorical or related to individual projects<br><br><u>Aquatic Vegetation</u> MA: see <u>Emergent Vegetation</u> immediately above<br><br>S: 1) convincingly demonstrated in the short-term (especially with successful draw-down), long-term differences less definitive - thus, concluding differences are definitive, representative and predictable outcome of all undertakings may be slightly optimistic; 2) probably a valid assumption in nearly all undertakings; 3) appears be an invalid assumption for some attributes, a valid assumption for others, but generally remains to be determined whether other potential biological differences are significant and whether such differences are categorical or related to individual projects | **PRIMARY PRODUCTION** has four constituent components:<br><br><u>Emergent Vegetation</u> MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) and 2) theoretically correct, intuitively appealing but presumptive - remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects; 3) see marsh management<br><br><u>Aquatic Vegetation</u> MA: and S: see above |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **PRIMARY PRODUCTION** (Continued)<br><br>Benthic algae<br><br>**PHYTO-PLANKTON**<br><br>OVERALL | Benthic algae/**PHYTOPLANKTON** MA: 1) management actions do not unduly affect these components of marshes; 2) any adverse effects are a- minimal or b- offset<br><br>S: 1) and 2)a- more likely to be true if water level drawdowns do not occur; 2)b- more likely to be true relative to net primary production....but phytoplankton contribution decreases largely as a function of pool stage whereas benthic algae can persist on moist soil surfaces even after the water is removed- thus, generally remains to be determined whether other potential biological differences (see **NUTRIENTS** and **FISH**) are significant and whether such differences are categorical or related to individual projects<br><br>OVERALL MA: Management enhances primary production<br><br>S: Management appears to be capable of enhancing some components but at the expense of others, such that net primary production between managed and unmanaged areas may not be very different - which components are enhanced is dictated by the purpose(s) of the project, the concomitant implications to managers are different matters | Benthic algae/**PHYTOPLANKTON** MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) and 2) theoretically correct, intuitively appealing but presumptive - remains to be determined in managed Louisiana marshes if any differences are significant and whether such differences are categorical or related to individual projects; 3) see marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SECONDARY PRODUCTION**<br><br>Of continuing interest to managers, especially relative to targeted animal species; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br>Zooplankton<br><br>Benthos | **SECONDARY PRODUCTION** can be thought of as having five constituent components:<br><br>Zooplankton and Benthos Never have been reasons to undertake management; function to reduce the particle size of organic materials; facilitates organic matter processing/nutrient cycling; includes immature forms of shrimp, fish and crabs<br><br>MA: 1) management actions that- a) stabilize salinity and, temperature, as well as water levels (sometimes seasonally, near, at or above the marsh soil surface), b) and/or lower and stabilize soil profile water levels above the marsh soil surface for a portion of the growing season in some years, especially in intermediate, brackish and saline marsh types, represent prudent and often necessary departures from ambient conditions to stimulate the production of emergent vegetation as well as improve the habitat of other secondary producers either directly or indirectly; 2) can be undertaken without unduly affecting other system attributes<br><br>S: 1) short-term responses appear to be generally as predicted, but response enhanced if a successful draw-down is achieved, long-term differences are less definitive because of the apparent inability to predictably achieve successful draw-downs; 2) appears be an invalid assumption for some species, a valid assumption for others, but generally remains to be determined in managed Louisiana marshes whether potential differences are significant and whether such differences are categorical or related to individual projects | Zooplankton and Benthos MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **SECONDARY PRODUCTION** (Continued)<br><br>*See Also*<br><br>**FISH, SHRIMP and CRABS**<br><br>**WILDLIFE**<br><br>**THREATENED AND ENDANGERED SPECIES**<br><br>**SOCIO-ECONOMICS** | **FISH, SHRIMP and CRABS/WILDLIFE**<br>MA: 1) management targeting specific species groups (i.e., waterfowl, furbearers) can be undertaken without unduly affecting other system attributes; 2) a- adverse effects can be minimized, b- any unavoidable adverse effects come close to or are offset/superseded by benefits derived from reduced erosion, increased primary production and/or components of secondary production favorably influenced by management efforts<br><br>S: 1) may prove to be a questionable/invalid assumption for any species whose life cycle cannot be completed within the managed area; 2)a- a valid assumption but accommodations often limited to those that won't compromise the goals/purpose of the project; 2)b- assumption remains to be verified as to whether any differences are significant and whether such differences are categorical or related to individual<br><br>**THREATENED AND ENDANGERED SPECIES** MA: 1) adverse impacts are avoidable; 2) indirect beneficiaries from marsh loss reduction (perpetuates habitat)<br><br>S: 1) procedures exist to meet this assumption; 2) conceptually true, but remains to be definitively determined whether any differences are significant and whether such differences are categorical or related to individual projects<br><br><u>OVERALL</u> MA: Management enhances/prolongs higher levels of secondary production<br><br>S: Management appears to be capable of enhancing the habitat quality of some components <u>but</u> at the expense of the productivity of others, such that secondary production between managed and unmanaged areas may not be very different - which components are enhanced is dictated by the purpose(s) of the project | **FISH, SHRIMP and CRABS/WILDLIFE** MA: 1) emulating some historic (often natural) condition is preferred; 2) any induced differences should generally be less; 3) only in exceptional cases is it necessary or prudent to repetitively reduce soil water levels and/or seasonally manipulate pool stages<br><br>S: 1) intuitively correct; 2) intuitively correct; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects; 3) dictated by project purpose<br><br>**THREATENED AND ENDANGERED SPECIES**<br>MA: and S: See **FISH, SHRIMP and CRABS/WILDLIFE**<br><br><u>OVERALL</u> MA: Emulating some historic (often natural) condition is perceived capable of enhancing/prolonging secondary production<br><br>S: The habitat quality of some components can be enhanced/prolonged <u>but</u> at the expense of the productivity of others, such that secondary production between managed and unmanaged areas may not be very different - which components are enhanced is dictated by the purpose(s) of the project; remains to be determined whether responses are significant and whether such responses are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **THREATENED AND ENDANGERED SPECIES/ MARINE MAMMALS**<br><br>Never a stand-alone reason for undertaking management; evaluated by CORPS and some agencies during project comment period and review<br><br>**Important Attributes**<br><br>Gulf sturgeon T<br>Pallid sturgeon E<br>Atlantic Ridley turtle E<br>Green turtle T<br>Leatherback turtle E<br>Loggerhead turtle T<br>Hawksbill turtle E<br>Alligator T<br>Brown pelican E<br>Southern bald eagle T<br>Arctic peregrine falcon T<br>Piping plover T<br>Humpback whale E<br>Finback whale E<br>Right whale E<br>Sei whale E<br>Sperm whale E<br>Louisiana black bear T<br>Florida panther E<br>Red wolf E | MA: Likely not to involve the sturgeons or whales, could involve some birds and turtles; careless construction/maintenance could have site-specific implications<br><br>S: Procedures exist to identify/resolve issues related to Threatened and Endangered Species and Marine Mammals; evaluation of projects by CORPS includes preliminary determination in public notice, and, as required, subsequent informal and/or formal consultation with the FWS and/or NMFS; (See also Appendix M) | MA: See marsh management<br><br>S: See marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SOCIO-ECONOMICS**<br><br>Some attributes stipulated reasons for undertaking management, others inferred reasons, most never have been reason for undertaking management; many attributes of increasing general public interest; evaluation by CORPS also encompasses the overall public interest perspective, inclusive of any expressed concerns from managers, any other agencies, and members of the general public<br><br>Important Attributes<br><br>Fish and Wildlife Resources<br>Commercial<br>Recreational<br><br>Flood Control<br><br>Land Use/Land Loss<br><br>Mineral/Petroleum Extraction<br><br>Farms | Fish and Wildlife - A principal or companion reason for undertaking management, often of paramount proprietary concern to landowners, often a concern of managers and leaseholders; unsuccessful management could have negative socioeconomic implications; project-specific and cumulative implications; North American Waterfowl Management Plan goals often cited as reason for undertaking (waterfowl) management<br><br>S: Available documentation apparently does not lend itself to detailed analyses; North American Waterfowl Management Plan Goals for Gulf coast initiative may have been met/exceeded<br><br>Flood Control - Never a stand alone reason for management; unsuccessful management may reduce flood control function; cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses; the affect on flood control remains to be documented<br><br>Land Use/Land Loss - A principal or companion reason for undertaking management; very often proprietary interest of landowners, of interest to managers, and leaseholders and members of general public; probably prolongs some uses; project-specific and cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses<br><br>Mineral/Petroleum Extraction - Apparently a compelling (but unstipulated) reason for undertaking some form of management, often involving boundary delineation with surface features; unsuccessful management likely to have little or no effect; project-specific and cumulative implications<br><br>S: Available documentation does not lend itself to detailed analyses<br><br>Farms - Never a reason to initiate management; seldom if ever an issue; evaluation by CORPS also includes consultation with the NRCS<br><br>S: Procedure exists to identify/resolve issues related to Prime and Unique Farmlands | Fish and Wildlife - Probably reduced to a companion reason for undertaking targeted species management; unsuccessful management could have negative implications; project-specific and cumulative implications; North American Waterfowl Management Plan goals could be cited as reason for undertaking (waterfowl) management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Flood Control - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Land Use/Land Loss - A principal or companion reason for undertaking management; very often proprietary interest of landowners, a concern of managers and of leaseholders, and members of general public; project-specific and cumulative implications<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Mineral/Petroleum Extraction MA: and S: See Marsh Management<br><br>Farms - MA: and S: See Marsh Management Never a reason to initiate management; seldom if ever an issue; evaluation by CORPS also includes consultation with the NRCS<br><br>S: See marsh management |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SOCIO-ECONOMICS** (Continued)<br><br>Other Business Interests<br><br>Property Value<br><br>Public Facilities and Services<br><br>Employment and Labor Force | Other Business Interests - An often project specific concern of managers, landowners, and leaseholders as well as members of the public and some other agencies; unsuccessful management could have destabilizing effect; cumulative implications<br><br>S: Available documentation does not lend itself to detailed analyses<br><br>Property Value - Protecting property values is an emerging but unstipulated proprietary reason for undertaking management; applicant's/landowners property rights sometimes cited as basis for pursuing proprietary interests in the face of expressed opposition; achieves some objectives; unsuccessful management could diminish property value; project-specific and cumulative implications<br><br>S: Could be basis for legal proceedings; some protection achieved; available documentation apparently does not lend itself to detailed analyses<br><br>Public Facilities and Services - Protection/enhancement of public holdings has been/likely to continue to be a reason for initiating/upgrading management efforts; project-specific and cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses<br><br>Employment and Labor Force - Never has been cited as a specific reason for undertaking management; tie-ins with Fish and Wildlife, Mineral and Petroleum Extraction, see also Income, Tax Revenues, Community and Regional Growth; unsuccessful management could have destabilizing effect; cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses | Other Business Interests - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Property Value - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Public Facilities and Services - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Employment and Labor Force - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SOCIO-ECONOMICS** (Continued)<br><br>Income<br><br>Displacement of People<br><br>Public Access | Income - Never has been a stipulated reason for management but see Fish and Wildlife Resources and Mineral/Petroleum Extraction; has positive effect on landowner and leaseholder; unsuccessful management could have destabilizing effect; project specific and cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses; however, the effect water control structures have on Displacement of People and Public Access, as well as FISH, SHRIMP AND CRABS, would suggest that some forms of marsh management and hydrologic restoration would likely have an adverse effect on the income potentials of some individual commercial fishermen on a project-by-project scale and could, in the future with additional management efforts, have an adverse cumulative effect on commercial fisherman in general in some of the basins but positive impacts to the landowner<br><br>Displacement of People - Never has been a stipulated reason for undertaking management of an area but see also Property Value and Ownership, Income, Public Access (immediately below); proprietary interests of landowners/leaseholders stemming from liability, vandalism and resource harvest are prominent; less than fully successful management could be inflammatory; project-specific and cumulative implications<br><br>S: One of most volatile issues; available documentation apparently does not lend itself to detailed analyses<br><br>Public Access - Never has been a stipulated, stand-alone reason for management but controlling access is an emerging proprietary concern of landowners (see Displacement of People, Public Access), of concern to managers and leaseholders and a highly important issue to some members of the general public; less than fully successful management could be inflammatory; project-specific and cumulative implications<br><br>S: Appears to be one of most volatile issues; has been/could again be basis for legal actions; available documentation apparently does not lend itself to detailed analyses | Income - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Displacement of People - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such differences are categorical or related to individual projects<br><br>Public Access - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SOCIO-ECONOMICS** (Continued)<br><br>Tax Revenues<br><br>Community/ Regional Growth<br><br>Health and Safety -<br><br>Community Cohesion<br><br>Aesthetics<br><br>Noise | Tax Revenues - Never has been a stipulated reason to manage, but applicant's/landowners property tax payments sometimes cited as basis for pursuing proprietary interests in the face of expressed opposition; unsuccessful management could have destabilizing effect; cumulative implications<br><br>S: Could be basis for legal actions; available documentation apparently does not lend itself to detailed analyses<br><br>Community/Regional Growth - Never has been a stipulated reason to manage; less than fully successful management could have destabilizing effect; cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses<br><br>Health and Safety - Never has been a stipulated reason to manage; a proprietary concern stemming form liability claims from accidents, likely basis for concern expressed at Displacement of People, Public Access<br><br>S: Available documentation apparently does not lend itself to detailed analyses<br><br>Community Cohesion - MA: Never has been a stipulated reason to manage; less than fully successful management could have destabilizing effect; cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses; however issues related to Public Access, and Displacement of People appears to have potential to be a significantly destabilizing effect on community cohesion<br><br>Aesthetics - Never has been a stipulated reason to manage; less than fully successful management could be inflammatory; project-specific and cumulative implications<br><br>S: Available documentation apparently does not lend itself to detailed analyses<br><br>Noise - Noise reduction has never has been a stipulated reason to manage; effects mostly to equipment operators during installation and maintenance operations; unsuccessful management could lessen noise levels in the marsh; project-specific implications<br><br>S: Available documentation apparently does not lend | Tax Revenues - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>Community/Regional Growth - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>Health and Safety - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>Community Cohesion - see marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>Aesthetics - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects<br><br>Noise - See marsh management<br><br>S: See marsh management; remains to be determined if any differences are significant and whether such difference are categorical or related to individual projects |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | AREAS SUBJECTED TO MARSH MANAGEMENT | AREAS SUBJECTED TO HYDROLOGIC RESTORATION |
|---|---|---|
| **SOCIO-ECONOMICS** (Continued)<br><br>Environ-mental Justice | Environmental Justice - Not a stipulated reason to manage; less than fully successful management could have undetermined effects; project-specific implications<br><br>S: Could be an issue if management actions are perceived as focusing on minority populations | Environmental Justice - Not a stipulated reason to manage; less than fully successful management could have undetermined project-specific implications<br><br>S: Could be an issue if management actions are perceived as focusing on minority populations |

## TABLE 4-1: COMPARISON OF MANAGEMENT ALTERNATIVES (Continued)

| SIGNIFICANT RESOURCES | INSIDE MARSH MANAGEMENT PROJECT AREAS | INSIDE HYDROLOGIC RESTORATION PROJECT AREAS |
|---|---|---|
| **CULTURAL**<br><br>Never has been a stipulated reason to manage; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br>Prehistoric<br><br>Historic | **CULTURAL**<br><br>Prehistoric - Careless construction/maintenance could have site-specific implications<br><br>S: Procedure exists to identify/resolve issues related to prehistoric resources on a case-by-case basis<br><br>Historic - Careless construction/maintenance could have site-specific implications<br><br>S: Procedure exists to identify/resolve issues related to prehistoric resources on a case-by-case basis | **CULTURAL**<br><br>Prehistoric - See marsh management<br><br>S: See marsh management<br><br>Historic - See marsh management<br><br>S: See marsh management |

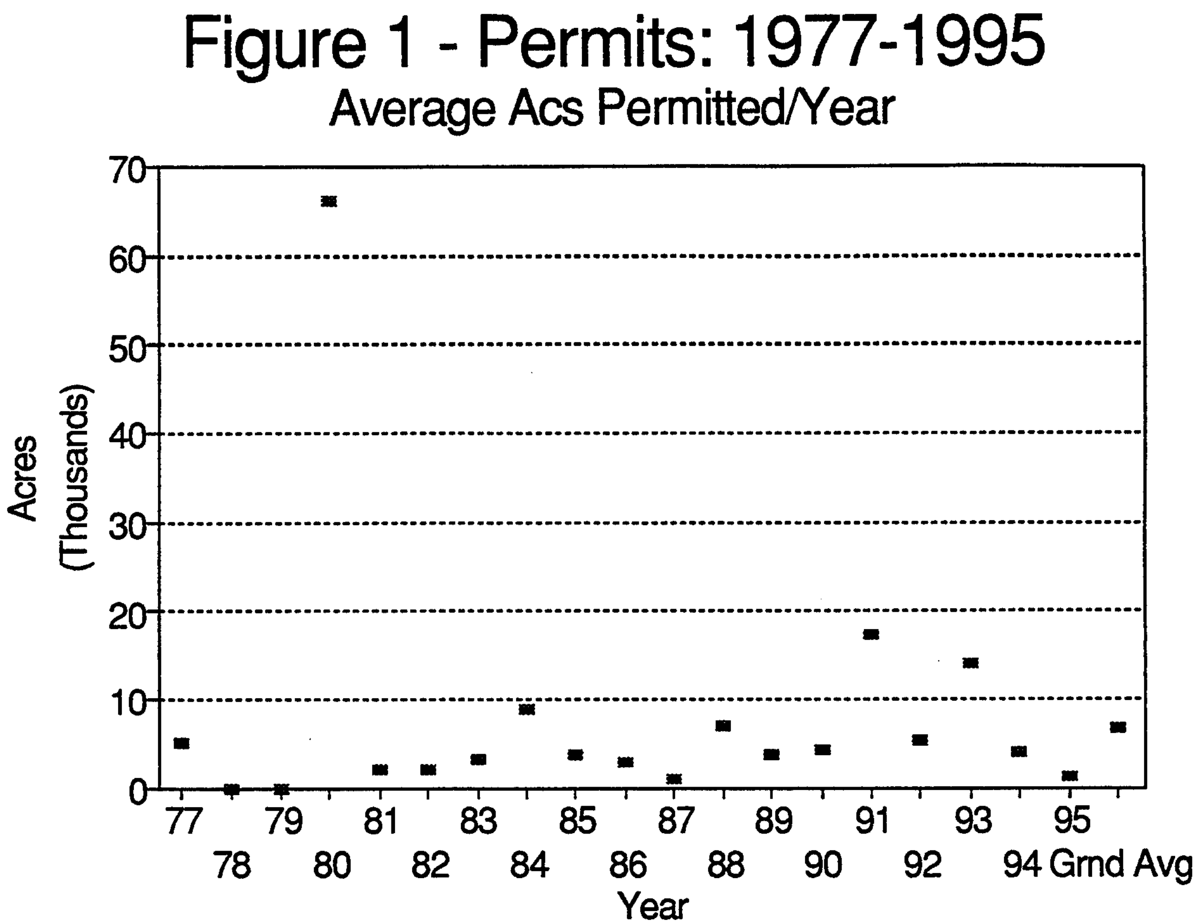
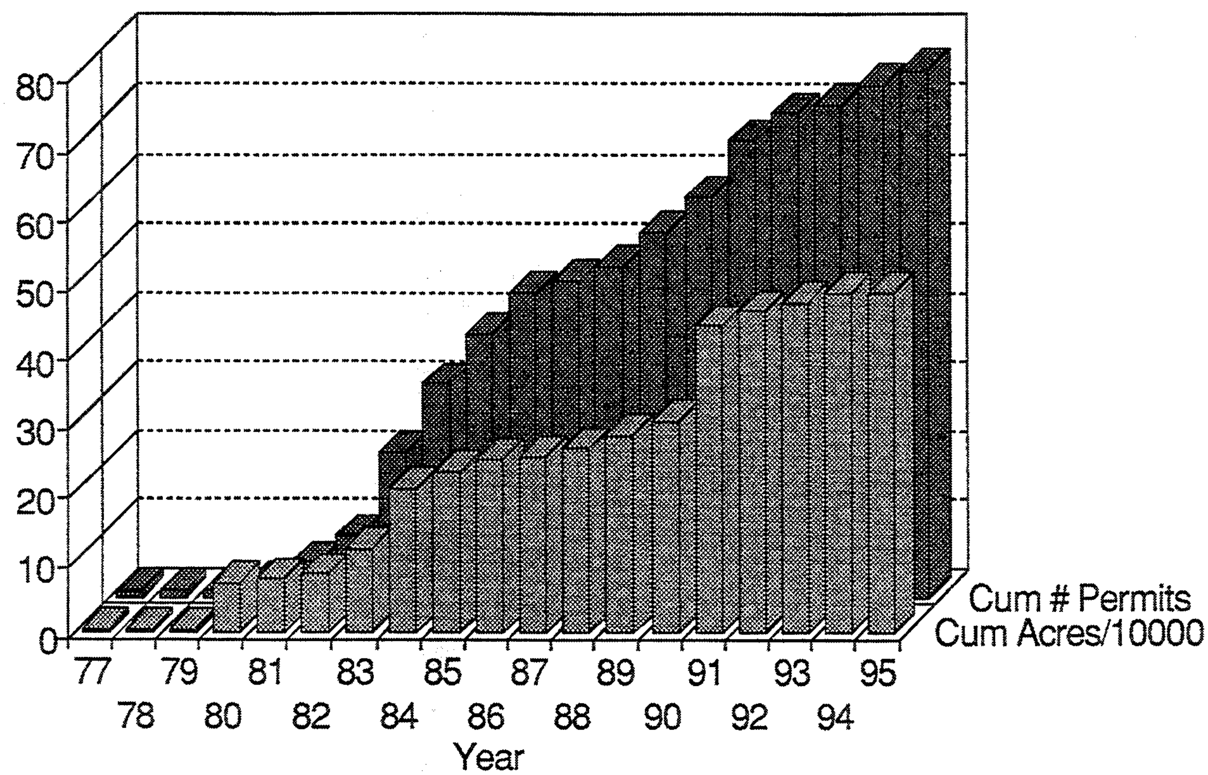


Figure 1 - Permits: 1977-1995
Average Acs Permitted/Year
Acres (Thousands)
0
10
20
30
40
50
60
70
77
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
Grnd Avg
Year

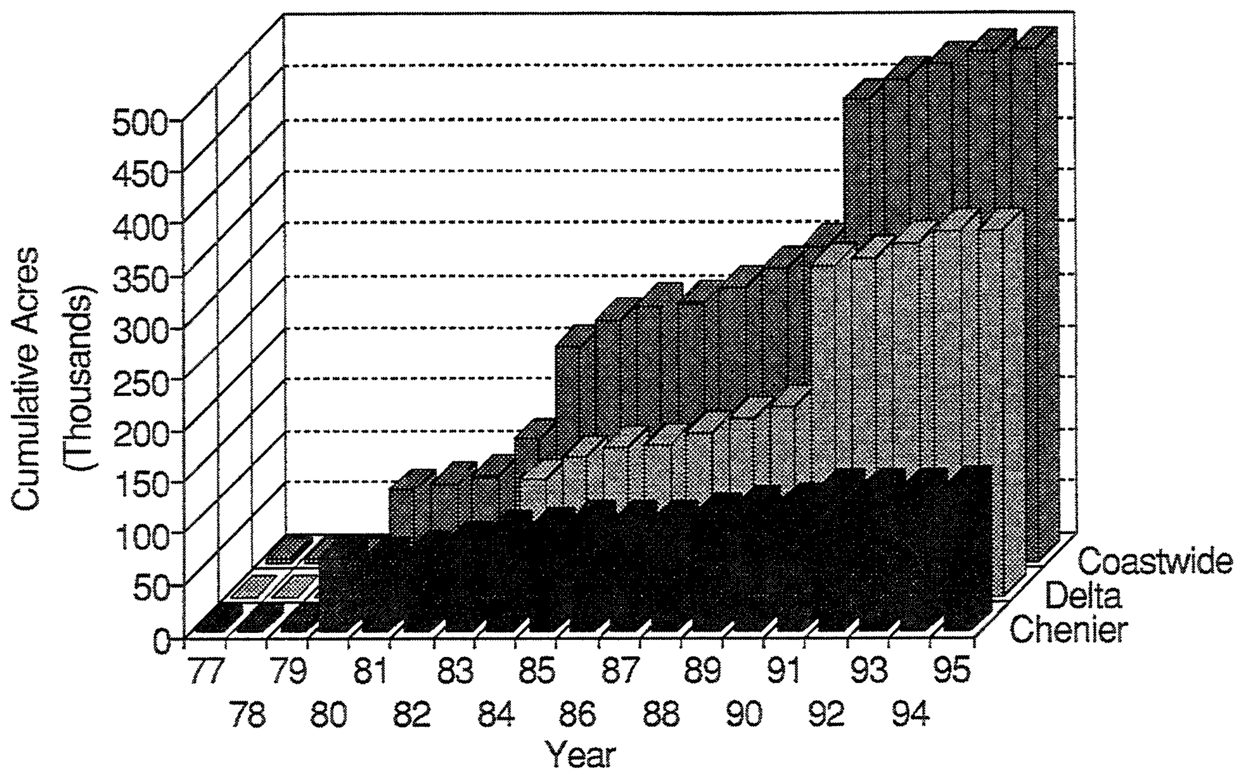
# Figure 2 - Permits: 1977-1995

## Cumulative Summary: # & Acres



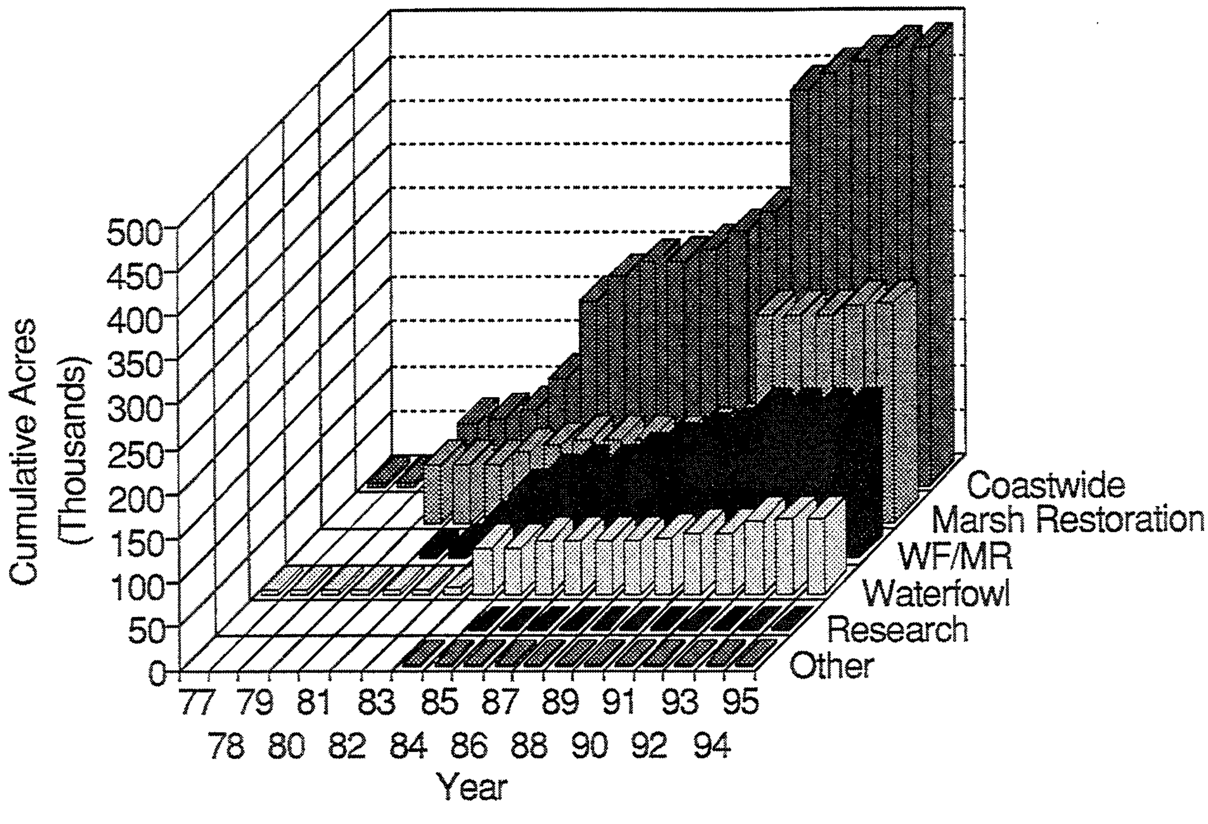
# Figure 3 - Permits: 1977-1995

## Year x Region



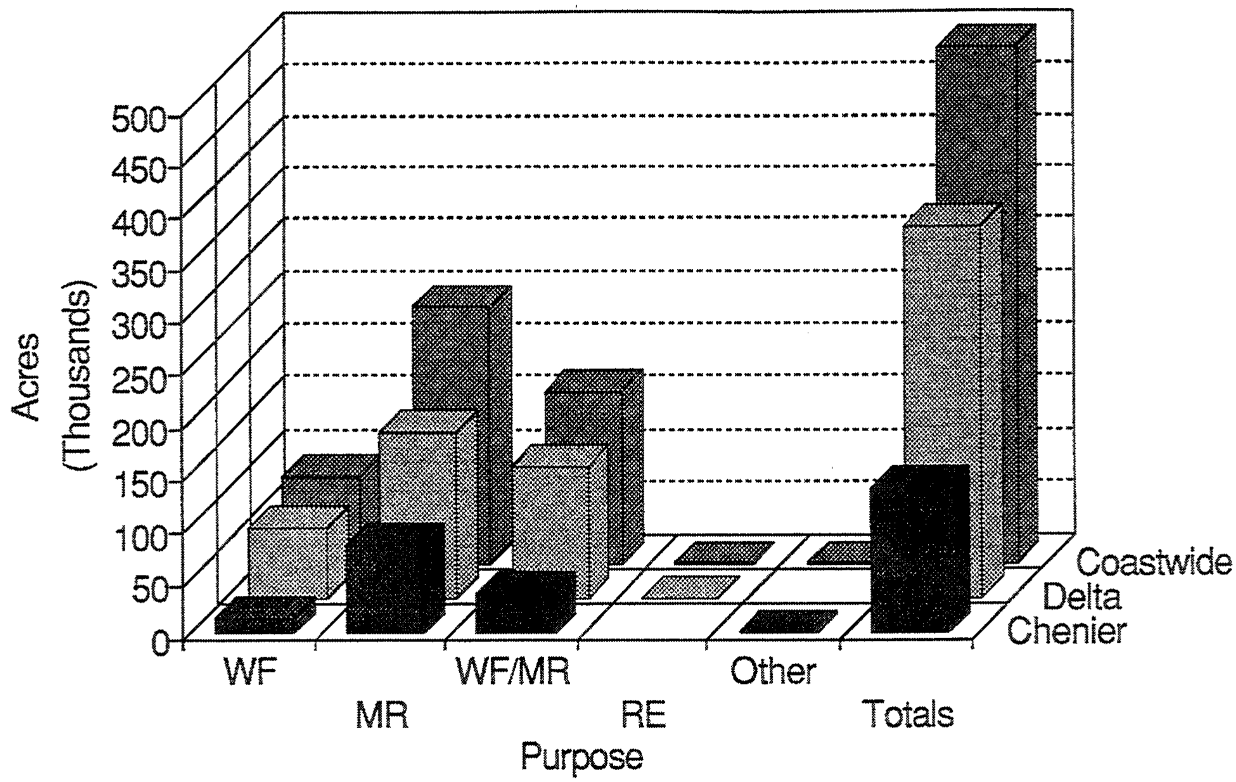
# Figure 4 - Permits: 1977-1995

## Year x Purpose



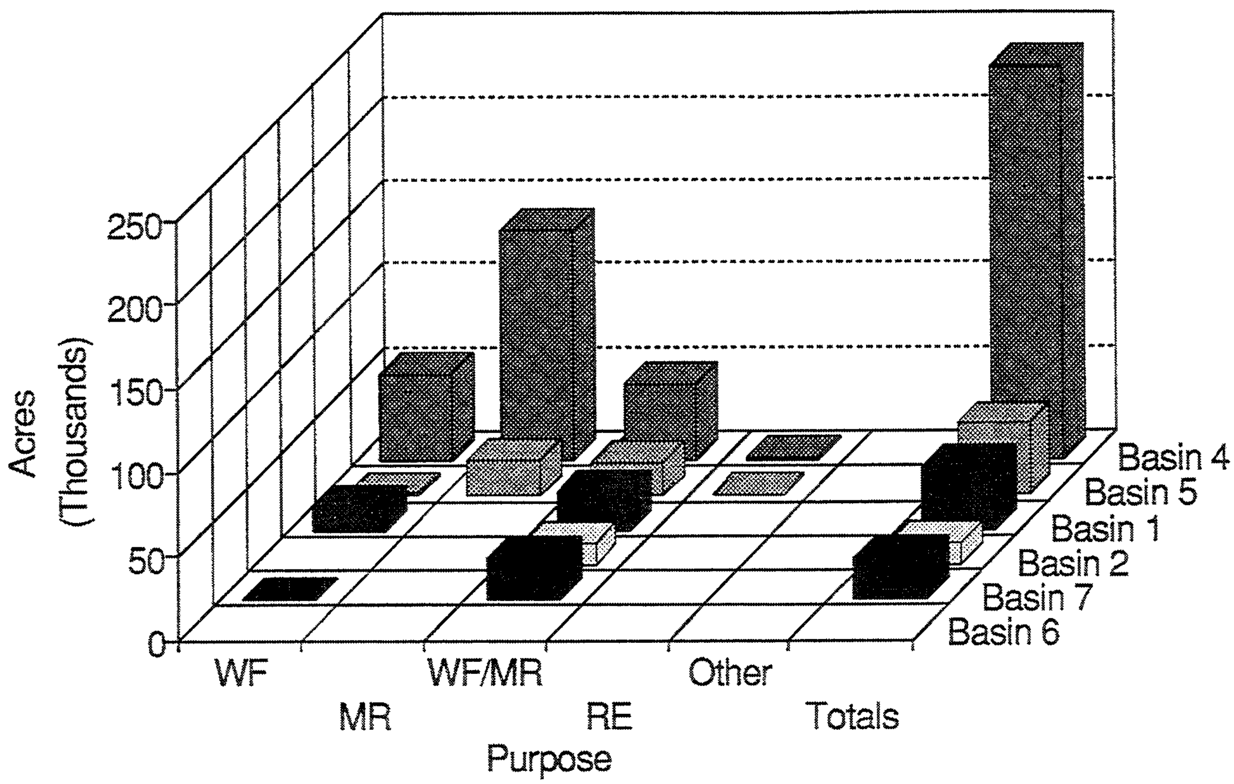
# Figure 5 - Permits: 1977-1995

Region x Purpose



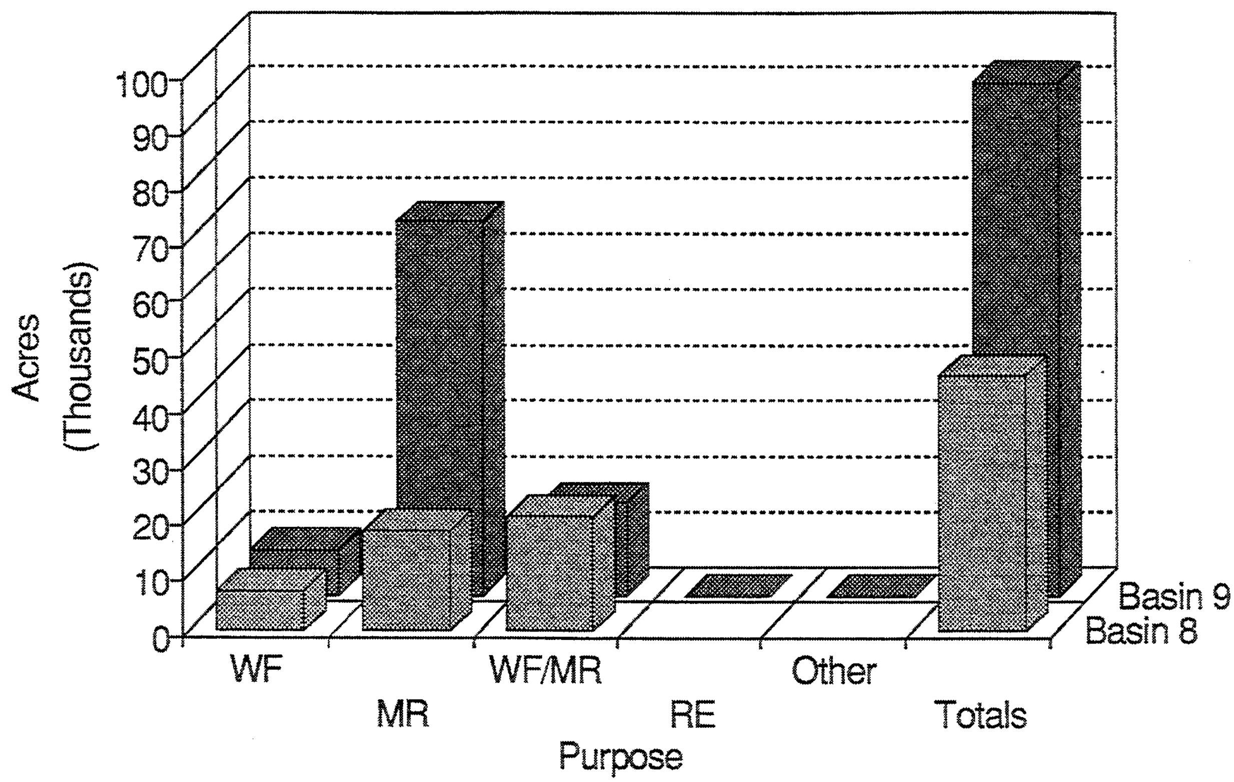
# Figure 6 - Permits: 1977-1995

## Delta Basins x Purpose



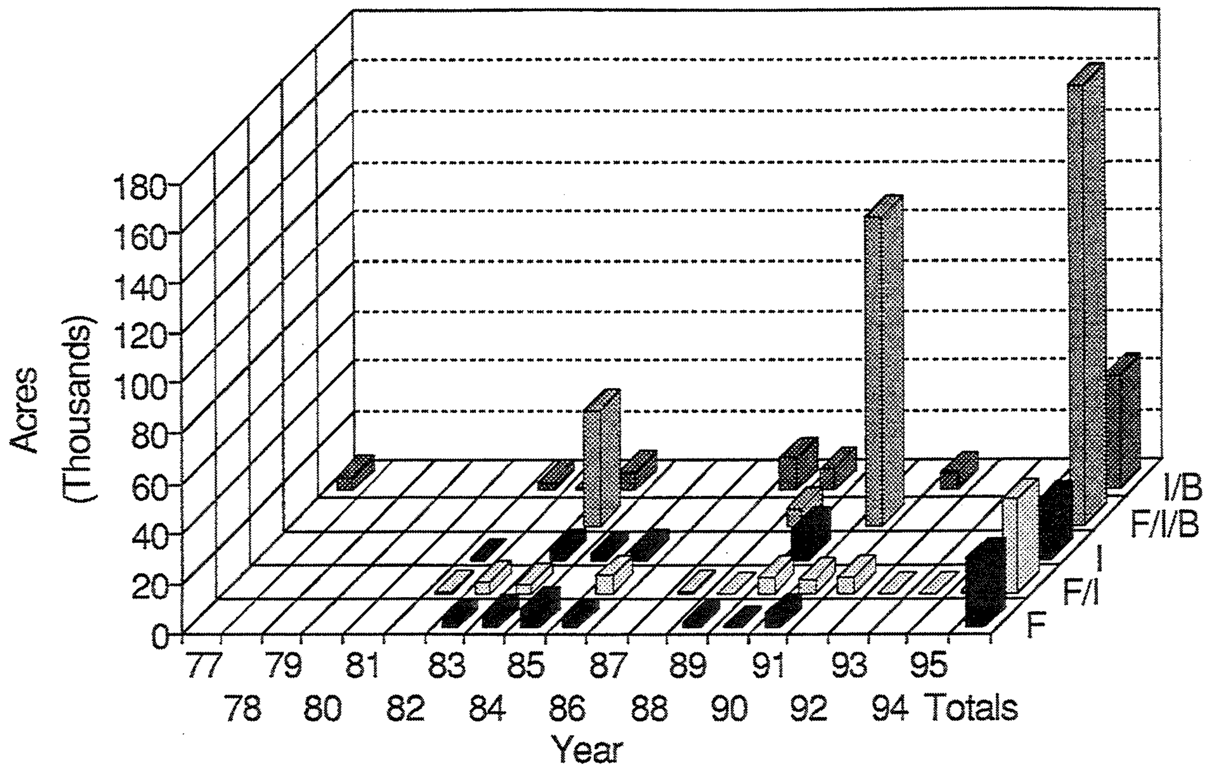
# Figure 7 - Permits: 1977-1995

## Chenier Basins x Purpose



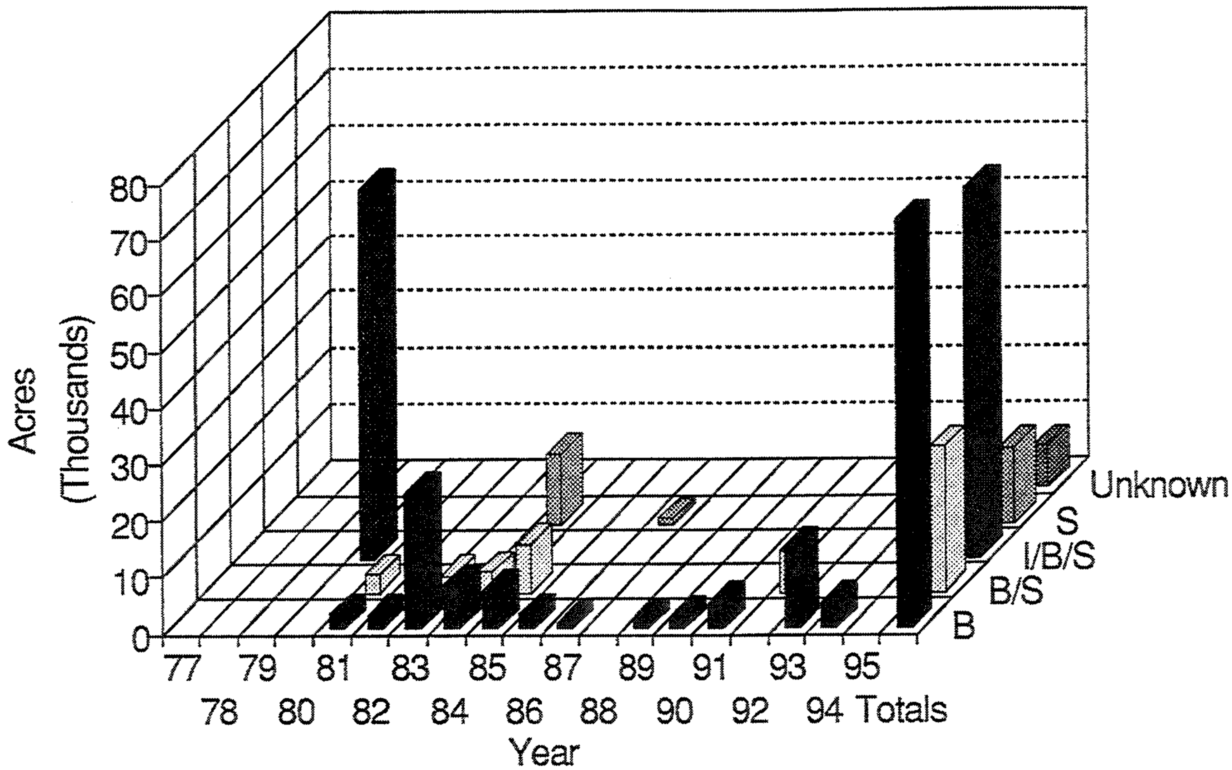
# Figure 8 - Permits: 1977-1995

## Marsh Type x Year



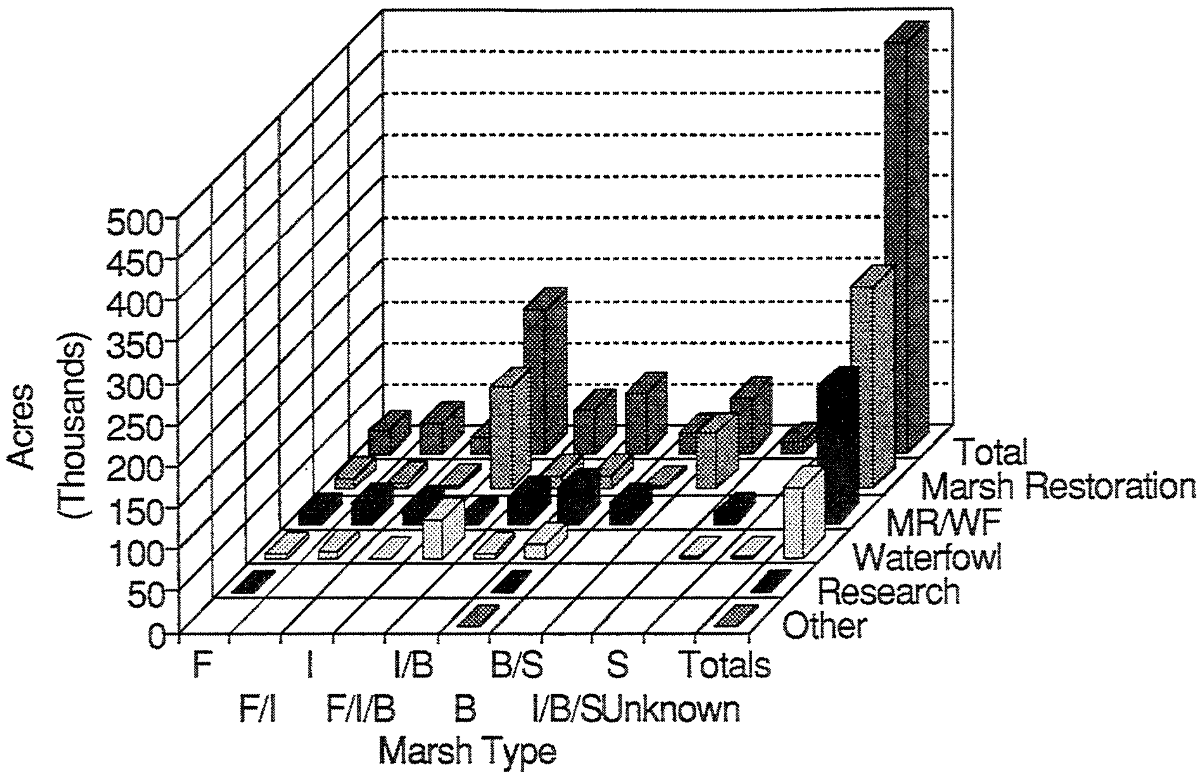
# Figure 9 - Permits: 1977-1995

Marsh Type x Year



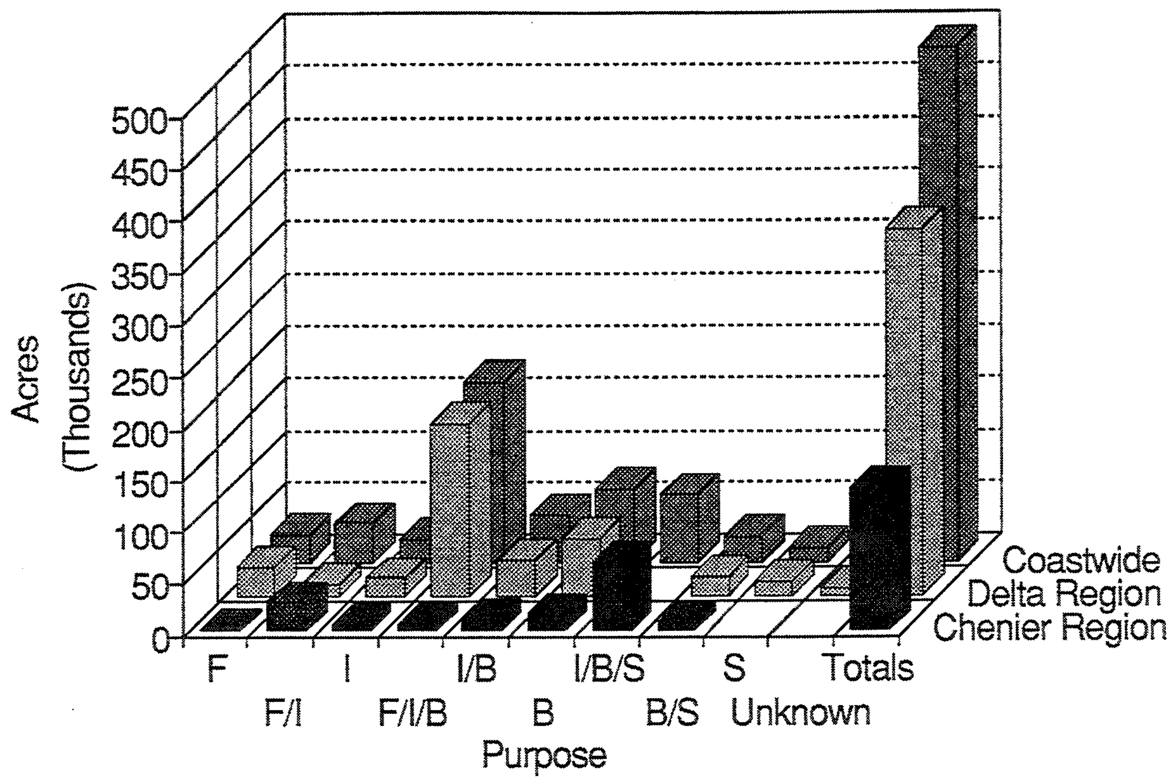
# Figure 10 - Permits: 1977-1995

## Purpose x Marsh Type



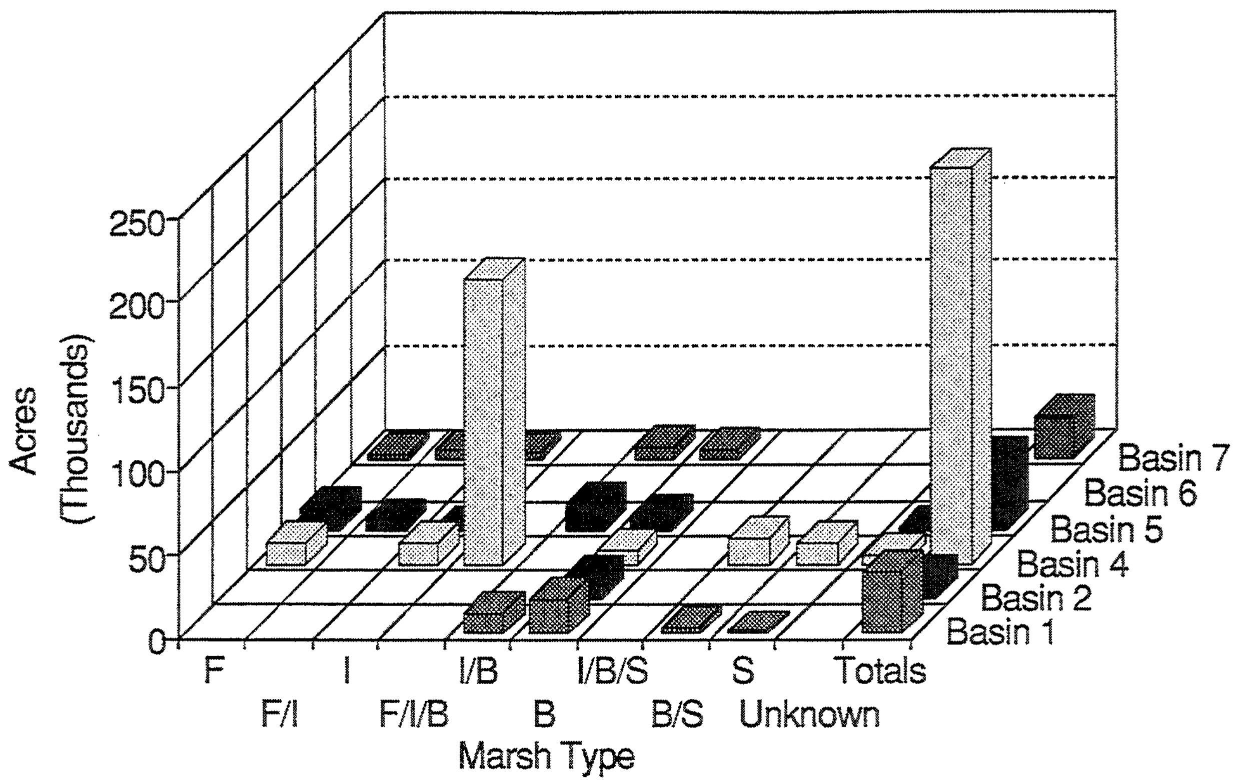
# Figure 11 - Permits: 1977-1995

## Region x Marsh Type



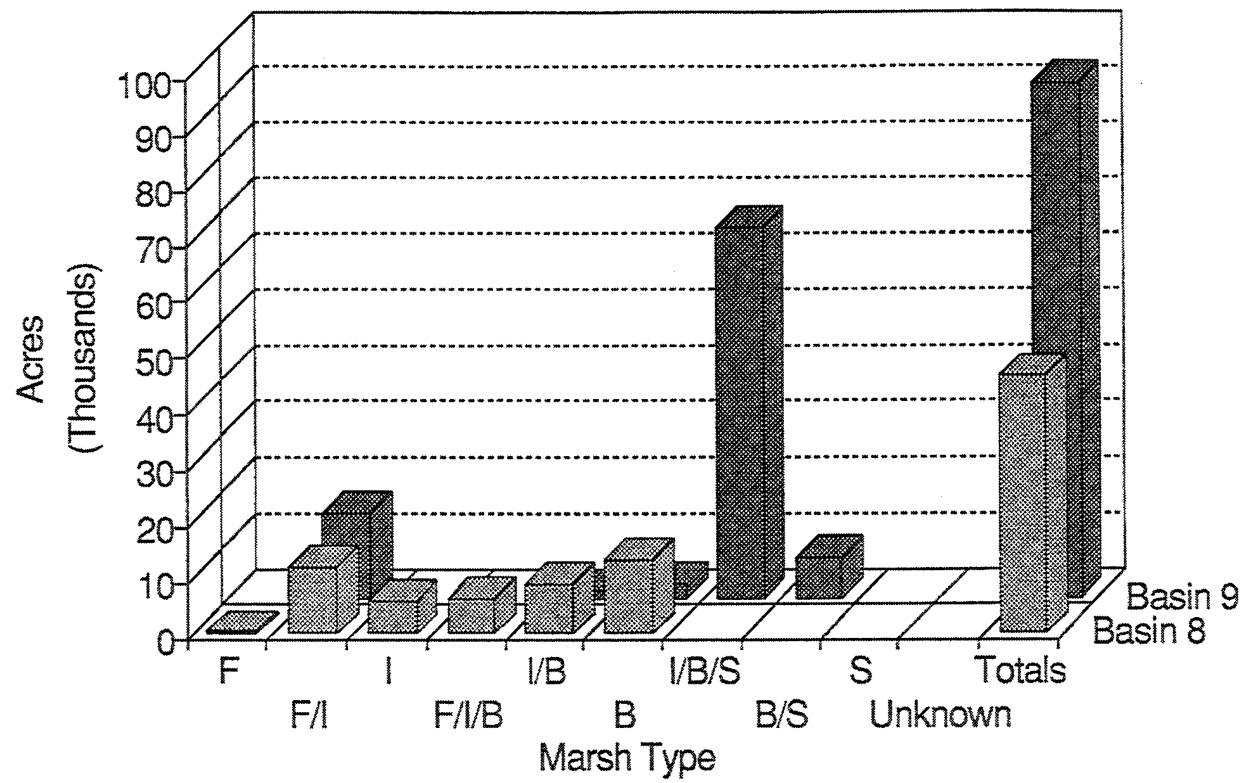
# Figure 12 - Permits: 1977-1995

## Delta Basins x Marsh Type



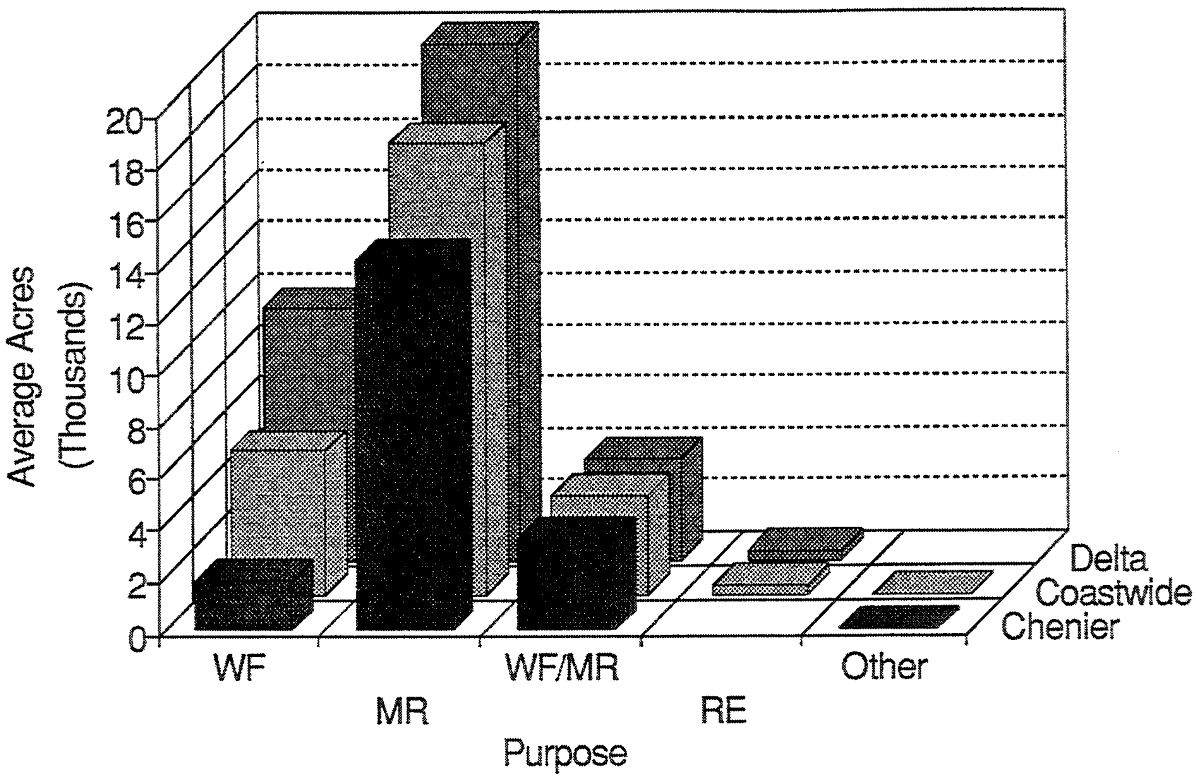
# Figure 13 - Permits: 1977-1995

Chenier Basins x Marsh Type



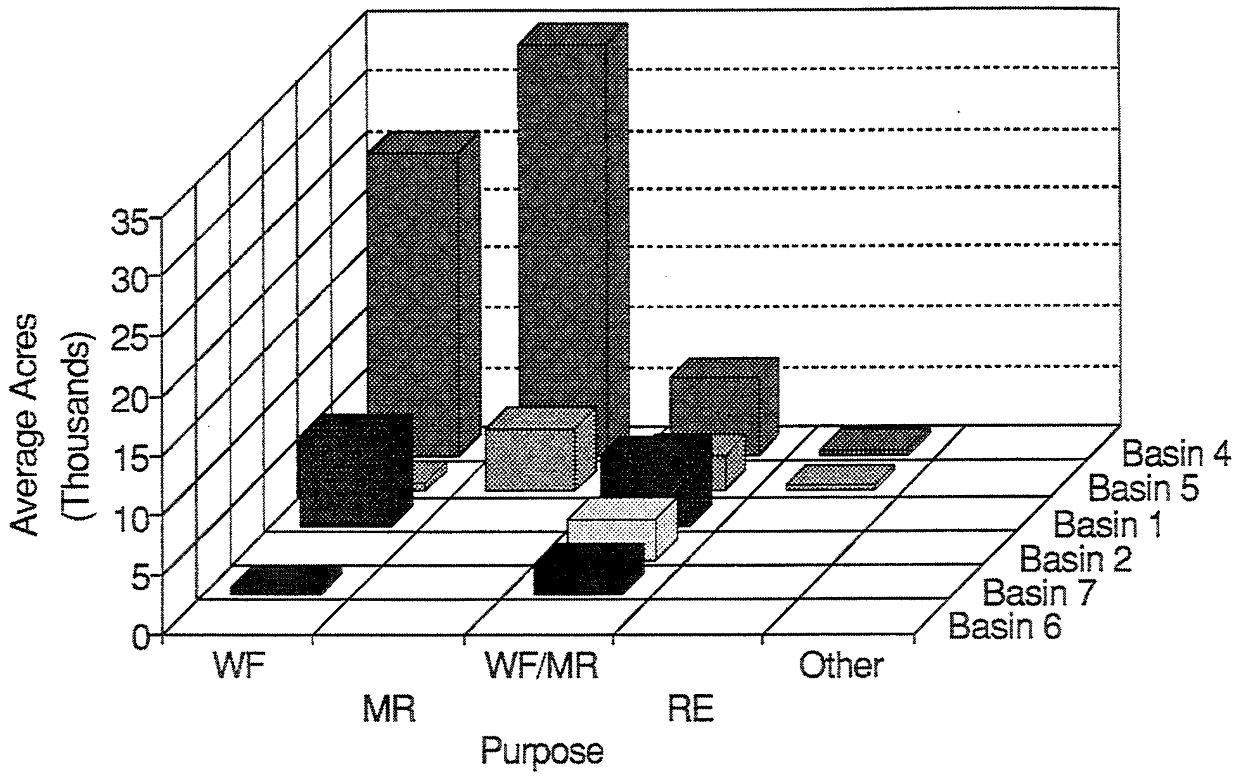
# Figure 14 - Permits: 1977-1995

Avgs: Region x Purpose



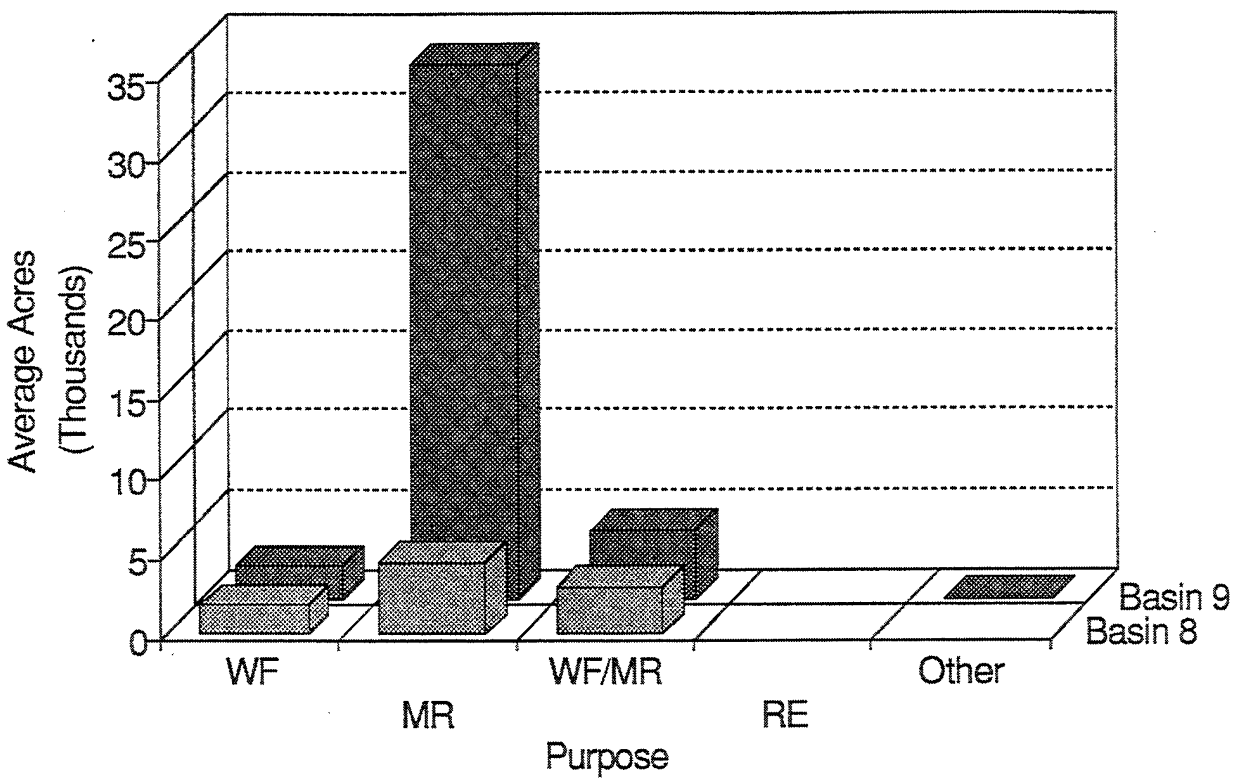
# Figure 15 - Permits: 1977-1995

## Avgs: Delta Basins x Purpose



# Figure 16 - Permits: 1977-1995

## Avgs: Chenier Basins x Purpose



## 5.0. ***IMPACTS AND EFFECTS OF PRIOR AND FUTURE ACTIONS***

Our goal was to present the reader with a comparison of what happens when undertaking management of a portion of Louisiana's coastal wetlands.

We assumed the reader was a member of the general public who was thinking about managing a piece of marsh or a regulator seeking information about the effects of management activities. We assumed members of the public would approach the matter as follows: they would know what basin they were in and would be more interested in their own basin and less interested in other basins; they had a reason in mind for wanting to manage (project purpose - e.g., slow marsh loss rate); what would happen if they did or didn't manage an area; and, finally, what kinds of management options were available.

Based upon our assumptions, we organized this section hierarchically. Within each basin, we listed attributes of the marsh system (we call them significant resources - e.g., fisheries, waterfowl). Then, we presented a side-by-side comparison of the impacts and effects of historic management, as well as a future without management and a future with management. For the future with management presentation, we also gave a side-by-side comparison of the impacts and effects of hydrologic restoration and marsh management.

Statements and insights about impacts and effects were retrieved/deduced from technical literature, inferred or concluded from both the permit history and CWPPRA publications and refined and updated subsequent to discussions with cooperating agencies. Information from Louisiana is the primary source of insight. Sources from other coastal marshes are identified.

Section 5.1. characterizes the impacts of permitted and candidate CWPPRA projects. An impact is an action that induces a change. Installation of a water control structure would induce a change in the hydrology. 5.2. characterizes the effects of impacts. Effects are what changes do or are expected to occur. How the significant resources associated with Louisiana's coastal marshes respond to the impact are effects. Section 5.3. is a summary, and includes conclusions.

All Figures referred to in this portion of the PHMEIS are presented at the end of this section.

### 5.1. **CWPPRA Projects, Land Loss and Permits**

Land loss information was derived from Appendix H. The reader is directed to refer to that appendix for details.

Future loss was considered to be more likely in areas that exhibited characteristics where historic losses have occurred. Thus, forecast losses represent possibilities, not certainties.

The identified areas were only identified in narrative form and not mapped because the boundaries are uncertain.

Project profiles were created from narratives included in CWPPRA Basin Plans (Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993), the NOD's draft land loss maps and inspection of aerial infra-red photography. Preparing abbreviated profiles of the candidate CWPPRA projects served several purposes. We noted differences in the available information about individual marshes targeted for management. For example, acreage estimates in one source may have been different than the estimate for the same area in another information source. The same kind of difference was noted regarding historic as well as current marsh type and condition. The individualized profiles were a way of relating historic and future land loss, marsh type changes (when that information was readily available), and suspected causes for changes and proposed solutions to specific pieces of marsh with individualized histories. They were also a ready way for readers to check our representation of the projects should they desire to do so.

### 5.1.1. Delta Basins

#### 5.1.1.1. Pontchartrain Basin

Exposed and protruding portions of the Lakes Pontchartrain and Borgne shorelines (especially the Lake Pontchartain shoreline near Chef Pass), Mississippi, Breton and Chandeleur Sounds, and the northern bankline of the Mississippi River Gulf Outlet are likely to continue to experience high rates of erosion due to wind or vessel wave action. Disrupted hydrologies are likely to be the reason for continued high erosion rates in the marsh associated with Bayou Savage, Fritchie marsh and the lake fringe marshes south of Slidell, LA.

If continued wave action breaks through the exposed shorelines, nearby small ponds will begin to erode at much faster rates. In Lake Pontchartrain, the potential appears to be greater near Point aux Herbes, south of Goose Lake (near Lacombe, La) and along a nearly four-mile stretch of lake shoreline just southwesterly from Pass Manchac. Proctor Point in Lake Borgne and the marshes that form rims

of Chandeleur, Breton and Mississippi Sounds are vulnerable.

5.1.1.1.1. Overview of Pontchartrain Basin CWPPRA Projects

Five CWPPRA projects are assumed to be viable candidates for future implementation (Plates 1 and 2, Table 5-1). All are intended to slow marsh loss, invigorate existing marsh and expand the amount of submerged aquatic vegetation.

In total 19,126 previously unmanaged acres could be brought under management via CWPPRA (Tables 5-1, 5-8, 5-14, 5-15, 5-16, 5-17 and 5-18; Figures 17, 22 and 23). However, project PO-15 adds no new managed acreage (as it was previously permitted) and project XPO-84 includes a previously permitted area, thus adding only some new managed acreage.

5.1.1.1.2. Profiles of Individual Pontchartrain Basin CWPPRA Projects

Project **PO-6** encompasses a 5,924-acre fresh/intermediate marsh area that has exhibited considerable interior marsh loss throughout the period of record. Higher water levels are suspected to have been part of the historic problem. Interior marsh loss is likely to continue due to higher water levels. To mimic historic conditions this passively operated hydrologic restoration project involves reestablishing historic fresh water and sediment introductions and the installation of a fixed-crest weir structure to prevent saltwater intrusion. The frequency, direction and duration of communications this managed area would retain with the unmanged estuary would be reduced to what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh. Attention to water levels may be called for.

Project **PO-11** encompasses a 3,915-acre brackish marsh area that has exhibited relatively high historic internal marsh losses, especially during the 1932-1974 time frame. That trend might accelerate. To mimic historic conditions this passively operated hydrologic restoration project involves rehabilitating debilitated water control structures (i.e., filling-in gaps in existing embankments, installing a rock plug and earthen dam) to reestablish control of the area's hydrology to reduce tidal scour and salinity intrusions. The frequency, direction and duration of communications this managed area would retain with the unmanged estuary would be reduced to what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh. Attention to the depth and duration of flooding may be called for.

Project **PO-15** encompasses a 15,578-acre brackish marsh area that has exhibited minimal internal land loss but relatively high shoreline erosion throughout the period of record. Shoreline erosion is expected to persist but any internal marsh losses that may be occurring are not anticipated to accelerate. To mimic historic conditions this actively operated hydrologic restoration project, previously permitted as a waterfowl/marsh restoration active marsh management project, involves the installation of new perimeter water control structures (i.e., earthen dams, variable crest weirs, timber/sheetpile and/or rock weirs) to gain control of the area's hydrology to reduce erosive tidal scour and control salinity. The frequency, direction and duration of communications this managed area would retain with the unmanged estuary would be reduced to what occurred through the adjustable structures and the rock weir and what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

Project **XPO-51** encompasses a 8,000-acre intermediate marsh area that has exhibited minimal internal land loss but relatively high shoreline erosion throughout the period of record. The targeted area is the Manchac Wildlife Management Area, a property administered by the Louisiana Department of Wildlife and Fisheries. Shoreline erosion is expected to persist but any internal marsh losses that may be occurring are not anticipated to accelerate. This actively operated marsh management project involves the installation of new water control structures (i.e., variable crest weirs fitted with flapgates) and gapping canal banks at strategic locations along the perimeter to gain control of the area's hydrology. The frequency, direction and duration of communications this managed area would retain with the unmanged estuary would be reduced to what occurred through the adjustable structures and what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

Project **XPO-84** encompasses a 2,089-acre brackish marsh area that has exhibited losses, especially during the 1958-1974 time frame. Very little internal marsh losses were recorded. Salt water intrusion and tidal action were the reasons implicated for the recorded erosion. To mimic historic conditions this passively operated hydrologic restoration project involves the installation of solid plugs in canals to reestablish control over the area's hydrology. The frequency, direction and duration of communications this managed area would retain with the unmanged estuary would be reduced to what could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

### 5.1.1.1.3. CWPPRA - Pontchartrain Basin Summary

Passively operated forms of hydrologic restoration would be the management option of choice for 11,126 acres of marsh, encompassing fresh, intermediate and brackish marsh types that would be brought under management for the first time (Tables 5-1, 5-8, 5-14, Figure 17). An actively managed form of hydrologic restoration is the management option of choice for a 15,578-acre brackish marsh formerly considered and permitted for management. Actively operated marsh management would be the management option of choice for 8,000 acres of intermediate marsh.

Quantitative similarities between the managed area and any particular historic time frame are unspecified. However, the tidal signals within every one of the managed areas would be only partially reflective of the tidal signal in the unmanaged portion of the estuary. Reduced tidal signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to the protection/restoration of several marsh types.

The projects exhibit a disconnected spatial relationship to one another (Plates 1 and 2). Therefore, it is unlikely that any of the four projects exerts an influence on any other.

All are intended to slow marsh loss, invigorate existing marsh and expand the amount of submerged aquatic vegetation

### 5.1.1.1.4. Pontchartrain Basin - Future with Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 56,618 acres would be brought under management, 37,490 from permits and 19,128 from candidate CWPPRA projects (Tables 5-1 and 5-20, Figure 22). The average size of the permitted projects was 6,248 acres (Table A-1). The average size for the CWPPRA projects would be 4,782 acres (Table 5-21, Figure 23).

By marsh type (Figure 19, Table 5-18) 8,000 acres of fresh marsh (active marsh management), 5,924 acres of fresh/intermediate (active hydrologic restoration), 12,640 acres of intermediate/brackish marsh (active marsh management), 26,140 acres of brackish marsh (active marsh management and active and passive hydrologic restoration), 3,080 acres of brackish/saline marsh types and 834 acres of saline marsh type would be managed.

Only about one-third of the permitted project acreage and

about half of the candidate CWPPRA project acreage encompasses marsh that has evidenced historic marsh losses (due apparently to either historic internal or historic and ongoing shoreline erosion).

The type and location of structures to be used would reduce the frequency, direction and duration of communications in every managed areas. For the passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions occur/should also be expected.

Project patterning is nearly entirely disconnected (Plates 1 and 2). Therefore, the consequences of management are more likely to be specific to and reflective of the individual project sites than of interactive effects.

5.1.1.2. Breton Basin

Shoreline erosion is likely to be a major contributing factor to an overall slight increase in loss rate in the foreseeable future.

Areas already where high loss rates are expected to continue include marsh shoreline bordering Black Bay and Breton Sound (wind-driven wave action), the interior marshes between Braithwaite and Bertrandville, near Lake Leary and Bayou Terre aux Boeufs (altered surface hydrology), and the marshes near Bay Denesse and Little Coquille Bay (high subsidence, shoreline erosion, altered hydrology).

Higher loss rates may occur where shoreline breaches occur (e.g., Grand Lake, Lake Petit) or where manmade landscape features have altered hydrology (e.g., marshes near Carlisle River aux Chenes).

No CWPPRA projects employing marsh management or hydrologic restoration as the management option of choice were assumed to be viable candidates for future implementation (Plate 3).

5.1.1.2.1. Overview of Breton Basin CWPPRA Projects

There are no proposed CWPPRA marsh management or hydrologic restoration projects proposed for this basin.

5.1.1.2.2. Breton Basin - Future with Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 13,572 acres would be brought under management,

from permits (Table A-2, Figure 22). There are no candidate CWPPRA marsh management or hydrologic restoration projects in this basin.

The average size of the permitted projects was 3,393 acres (Table A-2, Figure 23). By marsh type, only brackish marsh would continue to be managed. All the marshes targeted for management experienced predominantly interior losses as recently as 11 or as long as 20 years before the permitted restorative management actions were undertaken (1982-1983). Those losses can be correlated with hydrologic alterations caused by man-made surface landscape features and natural distributary levees and subsidence. The management option of choice was active marsh management.

The type and location of structures used reduced the frequency, direction and duration of communications every managed areas retained with the unmanged estuary. That reduction is what was designed or is allowed to seasonally occur through structures or what occurs over structures when tides rise to levels that overtop the structures or the marsh.

Project patterning is disconnected and adjacency (Plate 3). Therefore, the consequences of management are more likely to be specific to and reflective of the cluster of the three adjacent permits.

5.1.1.3. Barataria Basin

Losses ongoing in this basin today are likely to continue at a relatively high rate. Other locations are likely to exhibit accelerated loss rates during the foreseeable future. Altered hydrology could accelerate the marsh loss rates affecting the marshes on both sides of the Providence Canal east of Lake Des Allemandes, the marshes southeast of Crown Point, LA, and the marshes astride the Freeport Sulphur Canal near Grand Bayou.

Accelerated interior losses would likely be recorded if the shoreline is breached along the northwestern portion of Lake Salvador, areas near Little Lake, in the vicinity of Bayou l'Ours, and the marshes surrounded by Bayous Perot and Rigolettes.

5.1.1.3.1. Overview of Barataria Basin CWPPRA Projects

Eight CWPPRA projects are assumed to be viable candidates for future implementation (Plate 4, Table 5-3). Six projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. One project is intended to slow general marsh

losses. One other project is intended to slow shoreline and internal marsh losses.

In total 55,179 previously unmanaged acres could be brought under management via CWPPRA (Tables 5-3, 5-9, 5-14, 15, 16, 17, and 18; Figure 17, 22 and 23). Note that projects BA-2 and BA-6 add no new acres (as they were previously permitted), projects BA-14 and PBA-34 include previously permitted areas, and no acreage could be assigned to project PBA-32.

5.1.1.3.2. Profiles of Individual Barataria Basin CWPPRA Projects

Project **XBA-54** (a 38,887-acre brackish marsh area) and the **BA-2** project area (a 60,000-acre fresh/intermediate/brackish marsh area) encompass areas that have exhibited considerable interior marsh loss during the period of record. The XBA-54 project area exhibited the bulk of its loss during the 1974-1983 time frame, which may be correlated with an expansion of the canal system during the 1958-1974 time period. The BA-2 project area exhibited the bulk of its loss during the 1974-1990 time frames. Tidal scour and salinity intrusion resulting from hydrologic alterations are suspected to have been part of the historic problem in both project areas. Interior marsh loss for these same reasons is likely to continue in both areas. To mimic historic conditions, these actively operated hydrologic restoration projects involve pumping-in fresh water, and installing perimeter structures (XBA-54: solid and rock plugs, boat bays; BA-2: water control structures of unspecified design, solid plugs, 6-inch high dredged material embankment) to increase fresh water retention. The frequency, direction and duration of communications this managed area would retain with unmanaged areas would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment.

Project **BA-6** encompasses a 40,000-acre fresh/intermediate marsh area that has exhibited considerably losses during the period of record. Man-made marsh loss (excavation of canals and failed agricultural efforts) from the 1930's to the 1970's accounts for most of the loss. More recent interior losses, presumably the result of tidal scour induced by altered hydrology, is expected to continue. To mimic historic conditions this actively operated hydrologic restoration project involves better managing pumped, fresher water and sediment inputs and installing perimeter structures (i.e., rock weirs, earthen plugs, 6-inch high dredged material embankment) to increase fresh water and sediment retention and reduce tidal scour. The frequency,

direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the perimeter dredged material embankment.

Project **BA-14** (involving 2,548 acres of brackish marsh) encompasses a formerly managed area that has exhibited considerable interior marsh loss and some shoreline erosion throughout the period of record. Interior marsh losses due to subsidence and other effects altered hydrology has had on saltwater intrusion are expected to continue. This actively operated marsh management project involves the rehabilitation of old and installation of new perimeter structures of unspecified design to reacquire control of the area's hydrology to conduct active water level management. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the structures or during those occasions when tides rose to levels that overtopped the structures or surrounding embankments.

Project **PBA-32** encompasses a multi-thousand acre area of marsh that has exhibited considerable interior and some shoreline marsh loss during the period of record. Losses of both kinds are expected to continue. The preliminary design of this passively operated hydrologic restoration plan has not been formulated but will include shoreline erosion control features and the installation of plugs in canals. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred during those occasions when tides rose to levels that overtopped the structures or the marsh. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary probably would continue to be an unmuted tidal signal.

Project **PBA-34** involves 3,300 acres of brackish and intermediate marsh that has exhibited high rates of interior marsh loss, especially during the 1958-1983 time periods. Saltwater intrusion and tidal scour, related to the initial excavation of petroleum extraction canals during the 1930-1958 and an expansion of those canals during the 1958-1974 time frame, is suspected to have been part of the historic problem. Interior marsh loss for these same reason is likely to continue. To mimic historic hydrologic conditions this actively operated hydrologic restoration project involves managing pumped-in fresher water and installing solid structures in breaches in the natural ridge to

increase fresh water retention and reduce tidal scour. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be that which occurred from an unmuted tidal signal.

Project **PBA-35** involves 6,450 acres of fresh marsh that exhibited considerable losses during the period of record. Man-made losses (dredging of petroleum extraction canals primarily during the 1930-1958 time frame) and interior marsh loss account for most of the loss, although limited shoreline erosion losses have also occurred. Shoreline erosion and interior marsh losses, due primarily to tidal scour, are expected to continue. To mimic historic hydrologic conditions this passively operated hydrologic restoration project involves rehabilitating old (i.e., plugging breaches in existing embankments) and constructing new perimeter structures (i.e., rock weirs, solid plugs in canals) to reduce tidal exchange and reduce salt water intrusion. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

Project **PBA-61** involves 3,994 acres of fresh/intermediate marsh) has exhibited extensive shoreline erosional losses throughout the period of record. Man-made losses (dredging of petroleum extraction canals primarily during the 1930-1958 time frame) was also a cause of marsh loss. Shoreline erosion is expected to continue. To mimic historic hydrologic conditions this passively operated hydrologic restoration project involves the installation of solid plugs in canals. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred when tides rose to levels that overtopped the structures or the marsh.

5.1.1.3.3. CWPPRA - Barataria Basin Summary

Hydrologic restoration would be the management option of choice for 52,631 acres of marsh, encompassing fresh, intermediate and brackish marsh types (Tables 5-3, 5-9, 5-14, 5-15, 5-16 and 5-19; Figures 17 and 19). Passively operated hydrologic restoration would be implemented on 10,494 acres of marsh involving fresh and intermediate marsh types. Actively operated hydrologic restoration would be implemented on 42,187 acres of marsh involving fresh, intermediate and brackish marsh types. Actively operated marsh management would be the management option of choice for 2,548 acres of brackish marsh. Hydrologic restoration

is apparently perceived to be implementable over several marsh types whether or not the management is active or passive.

Quantitative similarities between the managed area and any particular historic time frame are unspecified. However, the tidal signals within every one of the managed areas would be only partially reflective of the tidal signal in the unmanaged portion of the estuary. Reduced tidal signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to the protection/restoration of several marsh types.

The projects exhibit disconnected, adjacent and capture spatial patterns relative to one another (Plate 4). Therefore, it is possible that several of the projects could exert an influence on adjacent or nearby projects, and a certainty that pre-existing projects would be affected when located within the boundaries of larger projects.

5.1.1.3.4. Barataria Basin - Future With Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 290,494 acres would be brought under management, 235,315 from permits and 55,179 from candidate CWPPRA projects (Table 5-20 and 5-21; Figure 7, 19, 22 and 23). The average size of the permitted projects was 15,688 acres (Table A-3, Figure 23). The average size for the CWPPRA projects would be 11,036 acres (Table 5-21, Figure 23).

By marsh type, 18,459 acres of fresh marsh (permits - active marsh management; CWPPRA - active hydrologic restoration), 12,400 acres of fresh/intermediate marsh (permits - active marsh management), 168,657 acres of fresh/intermediate/brackish marsh (permits - active marsh management, 53,181 acres of brackish marsh (permits and CWPPRA - active marsh management; CWPPRA - active hydrologic restoration) 15,223 acres of brackish/saline, 12,300 acres of saline and 6,250 acres of unclassified marsh type (all permits, all active marsh management) could be brought under management.

Nearly all of the permitted projects and candidate CWPPRA projects evidenced some historic marsh loss characterized as either historic and on-going internal marsh loss or historic and on-going shoreline erosion. For the permitted projects, internal marsh losses were either apparently caused by or accentuated by man's activities. More often than not, the candidate CWPPRA projects evidenced historic internal marsh losses, apparently caused by subsidence or caused by or accentuated by man's activities. Targeted marsh losses

largely occurred as much or more than 10 years ago.

Active management approaches, to include restoration of a management capability on formerly managed areas, predominate (Tables A-3, 5-9). The type and location of structures to be used would reduce the frequency, direction and duration of communications every managed areas would retain with the unmanged estuary. For the passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or what occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions occur/should also be expected.

Project patterning is disconnected, adjacency, and internal capture (Plate 4). Therefore, interactions between projects are highly likely (especially when a project is captured), possibly creating an interdependency situation. Additionally, the position of permitted and candidate CWPPRA projects along the southern edge of Lake Salvador and eastern rim of Lake Cataouatche (Plate 4) could/would create an upper and lower portion to the basin separated by a "belt" of managed wetlands spanning the distance between the Bayou Lafourche ridge to the west and natural ridge of Bayou Des Familles (a natural, historic distributary of the Mississippi River). Communication between the upper and lower portions of the basin would be reduced to major natural and man-made waterways. The operational schedule of some previously permitted projects may have to be modified once they come under the influence of the managed hydrology of nearby or encircling CWPPRA projects.

The management approach taken in this basin suggests that fragmenting the marsh into smaller, more "manageable" sizes, (Plate 4) and reestablishing former and upgrading current management capabilities are trade-offs perceived to be necessary to prolong the presence and improve the health of the marsh that remains.

5.1.1.4. Terrebonne Basin

Areas experiencing relatively high rates of shoreline erosion will persist. Relatively high rates of loss will likely persist at Avoca Island, northeast of Lake Cocodrie, in the marshes between Lost Lake and Lake Decade, in the marshes south of Falgout Canal between Bayou du Large and the Houma Navigation Canal, near Madison Bay, between Wonder Lake and Bayou Lafourche, east and south of Catfish Lake and north of Lake Boudreaux.

Areas that may evidence accelerated rates of loss are where

shoreline breaches occur, south of Bayou Blue (west of Grand Bayou Canal), between Little Lake and Bayou Lafourche, and south of Lake de Cade.

5.1.1.4.1. Overview of Basin CWPPRA Projects

Project **PTE-26**, a large hydrologic restoration project, is listed in Table but not included in the acreage estimates. That's because project PTE-26, when implemented, would actually consist of 12 smaller projects, each to be managed separately. Note also that this project encompasses the "footprints" of two previously permitted projects. Note also that projects that really consist of multiple smaller projects are tracked through their subordinate or component projects.

Thus, twenty-one CWPPRA projects are assumed to be viable candidates for future implementation (Plate 5, Tables 5-4, 5-10). If all are implemented they would involve 155,017 acres (Tables Table 5-4, 5-10, 5-14, 5-15, 5-16, 5-17, and 5-18; Figures 17, 22 and 23).

One project has as its single intent forestalling the advent of tidal and salt water stresses. One project has as its single intent the slowing of marsh losses. Two projects are intended to freshen the existing marsh. Four projects are intended to slow marsh loss rates, invigorate existing marsh and expand the amount of submerged aquatic vegetation. The remaining thirteen projects in some combination have as their purposes slowing marsh loss rate, invigorating and/or protecting existing marsh, and/or the expansion of submerged aquatic and or vegetated substrates.

5.1.1.4.2. Individual CWPPRA Project Profiles

The **PTE-26b** project area (7,200-acre fresh/intermediate/brackish marsh) is Unit 8 of Project PTE-26 and encompasses an area that has exhibited considerable interior marsh loss during the period of record. This project area is bisected by a natural ridge. Both portions of the project area have exhibited interior marsh loss since the 1930's. However, the bulk of the recorded loss in one area occurred during the 1930-1974 time frames whereas the bulk of the loss in the other portion occurred during the 1958-1974 time frame. The timing of the losses may be correlated to the time period during which petroleum extraction canal systems were excavated. The impacts of altering hydrology (greater tidal amplitude and salt water intrusion) are suspected to have been part of the historic problem. Interior marsh loss for these same reasons is likely to continue in both areas. To mimic historic conditions this actively operated hydrologic restoration

project involves the installation of perimeter structures consisting of one-way flap gated structures (to facilitate fresh water introductions), rock weirs (some with boat bays), and creation of 6-inch high dredged material embankments. The project area would be nearly completely surrounded by a hydrologic barrier with passively and actively managed water exchanges occurring most often at several specific locations. Thus, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment.

Project **PTE-23/XTE-33** encompasses a 15,587-acre brackish marsh area) that has exhibited internal marsh losses mostly during the 1930-1974 time frames, man-made losses (excavation of petroleum extraction canals) during the same time frame and shoreline erosion, of internal ponds and along the entire perimeter of the area, throughout the entire period of record. The impacts of altering hydrology (greater tidal amplitude and saltwater intrusion) are suspected to have been part of the historic internal marsh problem. Shoreline erosion is expected to continue. Internal marsh losses may continue to occur, but at a rate that can't be detected. To mimic historic conditions this actively operated hydrologic restoration project involves installing rock weirs and spillway structures in oil field canals, installation of a low sill structure in a natural bayou and the rehabilitation of an existing plug and bulkhead. The frequency, direction and duration of communications this managed area would retain with unmanged areas would be reduced to what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **TE-5** is Gulf-ward of the Parish Line of Defense (XTE-28 project alignment). The project area (a 35,857-acre fresh/intermediate/brackish marsh area) has exhibited internal marsh losses in the eastern one-third of the project area spanning the 1958-1990 time frames. Pipeline and petroleum extraction canals cross and lead to the area from the south. The impacts of altering hydrology (greater tidal amplitude and saltwater intrusion) are suspected to have been part of the historic internal marsh problem. Internal marsh losses are likely to continue. This actively operated marsh management project involves the creation of perimeter hydrologic barrier with dredged material fitted with variable crest weirs with flap-gated culverts. The project area would become an actively managed semi-

impoundment. Thus, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the surrounding dredged material embankment.

Project **TE-6** is Gulf-ward of the Parish Line of Defense (XTE-28 project alignment). The project area (a 5,407-acre brackish marsh area) has exhibited a relatively high internal marsh loss during the 1958-1990 time frames. The effects of altered hydrology (greater tidal amplitude, saltwater intrusion) in the vicinity and subsidence are suspected to have been part of the historic problem. Because the area is largely shallow open water, wind-driven waves are expected to contribute to continuing erosion. This actively operated marsh management project involves construction of a perimeter levee, maintenance of a natural levee, and the installation of water control structures. The project area would become an actively managed semi-impoundment. Thus, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Three of the four **TE-7** component project areas are on the land side of the Parish Line of Defense (XTE-28) alignment. The composite TE-7 project area encompasses fresh/intermediate and brackish marsh types. Only component 7d is Gulf-ward of the XTE-28 alignment. All four component project areas have exhibited internal marsh loss. Losses in 7a appear to be related to the effects resulting from the excavation of a petroleum extraction canal system. Internal losses in 7b and 7c are not easily linked to oil and gas exploration activities but do evidence ongoing shoreline erosion of Lake Boudreaux that spans the period of record. In 7d, measurable erosion of the shorelines of naturally occurring open water areas occurred over discrete time frames in some instances and throughout the period of record in other nearby locations. The 5,000-acre 7a project area will be an actively operated marsh management area. Thus, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would

be reduced to what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. The management of the other areas would be primarily passive. The hydrology of 7b and 7c would be reflective of the hydrological effects of XTE-28 on the Lake Boudreaux basin. Thus, the frequency, direction and duration of communications those managed area would retain with the unmanaged estuary would be greatly muted. reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

The **TE-8** project area is on the landward side of the XTE-28 project alignment. The project area encompasses 2,400 acres of fresh/intermediate marsh. The project area has exhibited internal marsh losses throughout the period of record. The bulk of those losses occurred in the southern portion of the project area during the 1930-1974 time frames. The effects of the Houma Navigation Canal (HNC), increased tidal amplitude, redirected surface flow patterns, possibly impeded drainage, and saltwater intrusion through breaches in the canal's embankments, are suspected to have been part of the historic problem. This actively operated marsh management project involves closure of embankment breaches and the installation of adjustable water control structures to facilitate fresh water retention, exchange and flow-through. Some active water level management is called for. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures that opened to the HNC. Otherwise this managed area would communicate with the managed marsh landward of the XTE-28 project.

Project **TE-19** encompasses a 4,558-acre intermediate/brackish marsh area that has exhibited relatively high internal marsh loss since 1958, especially in the northern half of the project area. Man-made losses (excavation of petroleum extraction canals) during the 1930-1958 time frame account for the recorded losses in the southern half of the project area. The impacts of altering hydrology (greater tidal amplitude and saltwater intrusion) are suspected to have been part of the historic internal marsh loss problem in the northern half. Because the northern half is largely shallow open water, wind-driven waves are expected to contribute to continuing erosion. To mimic historic conditions this actively operated hydrologic restoration project involves installing solid plugs in the mouths of each of the 15 canals and reconstructing a levee along the northern boundary to forestall overflow from a man-made canal. The

frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be that of an unmuted tidal signal.

Project **XTE-56** encompasses a 2,248-acre brackish marsh area that has exhibited interior marsh loss throughout the period of record but the bulk occurred during the 1930-1958 time frame. The losses are presumed related to the hydrological effects of the nearby HNC. Because the project area includes shallow open water areas, wind-driven waves are expected to contribute to continuing erosion. To mimic historic conditions this passively operated hydrologic restoration project involves sealing existing breaches in the HNC embankments and reinforcing locations where breaches of the HNC embankment are eminent. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be what occurred as a function of an unmuted tidal signal.

Project **XTE-57** encompasses a 6,090-acre brackish marsh area that has exhibited relatively high internal marsh loss, primarily during the 1930's-1974 time frame. Construction of pipeline and petroleum extraction canals during those time frames are suspected of having altered the hydrology. Because the project area includes shallow open water areas, wind-driven waves are expected to contribute to continuing erosion. To mimic historic conditions this passively operated hydrologic project involves installation of a water control structure to regulate inputs from a man-made canal to the north, placement of a solid plug in a pipeline canal and maintenance of some existing embankments to diminish inputs. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred in unaltered natural waterways and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the marsh.

Project **XTE-47/XTE-48** would bring 8,106 acres of brackish marsh under management. The project area has exhibited localized internal marsh loss (during the 1958-1983 time frames), especially along the southern perimeter, in close association with a petroleum extraction canal system excavated during the 1930-1974 time frames. The canal system's effect on altering the hydrology is suspected of being part of the historical internal marsh loss problem. Any losses that may have occurred since then have not been measurable. Because the area contains shallow open water, wind-driven waves may contribute to any continuing erosion. This actively operated marsh management project involves the installation of drainage structures (design unspecified) and the control of fresh water inputs to facilitate a flow-

through management situations. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures, the marsh or any future embankments that may be constructed.

The **TE-9** project area is wholly within the hydrologic boundaries of project XTE-47/XTE-48 but could be operated independently. The TE-9 project area (a 750-acre brackish marsh) encompasses an area that has exhibited relatively high internal marsh loss during the 1954-1978 time frame. The effects of excavating petroleum extraction canals prior to and during that time frame are suspected of being part of the reason for the recorded marsh loss in the TE-9 project area. This actively operated marsh management project involves installation of variable-crest water control structures (to facilitate water level drawdowns) and embankment construction. The project area would become a semi-impoundment. As a semi-impoundment, the frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what occurred from pumped inputs, through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment. However, even that degree of muted comminution could be further diminished because this project may be encircled by another project area that could also be actively managed.

Project **XTE-58** encompasses a 18,206-acre brackish marsh area) that has exhibited internal, man-made and shoreline losses. The internal losses occurred throughout the period of record, often during or after the time period during which the man-made losses (pipeline and petroleum extraction canals) occurred. By comparison the shoreline losses on along the margins of larger, natural open water areas has been small. Marsh losses are expected to continue from all causes. To mimic historic conditions this passively operated hydrologic restoration project involves embankment maintenance, the construction of 6-inch high overflow embankments and the installation of several water control structures (to facilitate the input of and control direction of flow of fresher water and guard against impoundment). The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

The 18,350-acre brackish marsh **PTE-25** project area is encompassed within other project footprints.

The **XTE-60** project would bring a 11,080-acre brackish marsh area under management. However, project XTE-29 (see below) would more specifically involve 3,858 acres of this larger area. The reaming portion of the XTE-60 project are would bring 7,222 acres under management. The XTE-60 project area is comprised of an area that has exhibited relatively high interior marsh loss that has occurred during the 1958-1990 time frames. Construction of pipeline and petroleum extraction canals during those time frames are suspected of having altered the hydrology. Losses in this and the nearby Madison Bay area to the south are expected to remain high. To mimic historic conditions this passively operated hydrologic restoration project involves work primarily along the southern boundary consisting of the installation of structures in selected man-made and natural waterways, the creation of marsh and the rebuilding of embankments. Because the upgraded southern boundary would consist largely of natural and recreated marsh, and structures in man-made waterways, the hydrology of the area would continue to be open to tidal exchange.

The **XTE-29** project area (a 3,858-ace brackish marsh area) is roughly the northern half of the XTE-60 project area. This actively operated marsh management project involves the rehabilitation of existing perimeter embankments and the installation of four variable crest weirs (presumably also fitted with flap-gated culverts). The project area would become a semi-impoundment within which water level drawdowns to expose eroded surface could be undertaken.

Project **XTE-55** encompasses a 12,266-acre brackish marsh area that exhibited relatively high internal marsh loss. The bulk of the loss occurred during the 1958-1983 time frame in close association with petroleum extraction canals constructed during the 1930's to 1974 time frames. The canal system's effect on altering the hydrology is suspected of being part of the historical internal marsh loss problem. Relatively high internal marsh losses are expected to continue. To mimic historic conditions this passively operated hydrologic restoration project involves the installation of water control structures along the northern and eastern boundaries. The structures would allow control of fresh water inputs and reduce inputs from the HNC to overflows only. Because no structures or work would occur along the southern boundary, the project area would remain an open system that exhibited an unmuted tidal signal.

Project **XTE-59** encompasses a 4,544-acre brackish marsh area that has exhibited interior marsh loss and shoreline

erosion. The marsh loss occurred during the 1930's-1983 time frames. Two "nodes" are evident. One node occurs in the extreme northern portion, in association with a petroleum extraction canal excavated during the 1958-1974 time frame. The other node occurs during the 1958-1974 time frame in the form of a band (with an east-west orientation) at what could be the southern limit of the project's area of effect. The recorded shoreline erosion occurred along the souther rim of Lake de Cade, primarily during the 1930-1958 time frame. To mimic historic conditions this passively operated hydrologic restoration project involves work along the western and northern perimeters. A structure would be installed in the southern Lake de Cade shoreline to allow for fresher water introductions. Another structure would be installed to relive an impoundment situation in the northern-most portion of the project area. Elsewhere, the project area would remain open and would continue to exhibit an unmuted tidal signal.

The **PTE-22/24** project areas (collectively a 5,230-acre brackish marsh area) encompass areas that have exhibited primarily man-made and some internal marsh loss. Each area is influenced by a canal that is open to the Gulf. To mimic historic conditions this passively operated hydrologic restoration project involves to construction of solid plugs in the canals near the Gulf, some backfilling and the installation of solid plugs at more inland locations in the canals. The man-made direct hydrologic link to the Gulf would be closed and marsh created on the backfilled areas. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

5.1.1.4.3. Terrebonne Basin Summary

Hydrologic restoration would be the management option of choice for 87,751 acres of marsh involving fresh, intermediate and brackish marsh types (Tables 5-4, 5-10, 5-14, 5-15 and 5-16; Figure 17). Passively operated hydrologic restoration would be implemented on 48,647 acres of marsh involving the brackish marsh type. Actively operated hydrologic restoration would be implemented on 27,345 acres encompassing the fresh, intermediate and brackish marsh types. Actively operated marsh management would be the management option of choice for 67,266 acres of marsh involving fresh, intermediate and brackish marsh types (Tables 5-4, 5-10, 5-14, 5-15 and 5-16; Figure 17). Active and passively operated hydrologic restoration and actively operated marsh management are apparently perceived to be conducive to the protection/restoration of several marsh

types whether or not the management is active or passive.

Quantitative comparisons between the management of an area and any particular historic time frame are unspecified. However, the tidal signals within most marsh types, would be only partially reflective of the tidal signal in the unmanaged portion of the estuary. Reduced tidal signals within managed areas, whether achieved through application of active or passive measures, are apparently perceived to be conducive to the protection/restoration of several marsh types.

The projects exhibit complex spatial pattern relative to one another (Plate 5). Therefore, it interactions/interdependencies between projects are likely to occur.

5.1.1.4.4. Terrebonne Basin - Future With Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 196,965 acres would be brought under management, 42,148 from permits and 154,817 from candidate CWPPRA projects (Tables 5-20, 5-2, 5-22, 5-23 and 5-24; Figure 22 and 23). The average size for the candidate CWPPRA projects would be more than double (7,741 acres) the average size (3,011 acres) of the formerly permitted projects (Table , Figure 23).

By marsh type, 12,6318 acres of fresh marsh (permits - active marsh management), 10,225 acres of fresh/intermediate (permits - active and passive marsh management; CWPPRA - active marsh management), 456 acres of intermediate marsh (permits - active marsh management), 43,057 acres of fresh/intermediate/brackish marsh (CWPPRA - active marsh management and hydrologic restoration), 19,780 acres of intermediate/brackish marsh (permits and CWPPRA - active marsh management), and 97,228 acres of brackish marsh (permits and CWPPRA - active marsh management and active and passive hydrologic restoration) would be managed.

Only two previously permitted waterfowl-only projects (encompassing 1,544 acres under active marsh management) show no measurable amounts of historic marsh losses. All other permitted project sites exhibited historic losses apparently due to historic and ongoing shoreline erosion and historic internal marsh losses caused by or accentuated by man's activities. The bulk of those losses occurred prior to the mid-1980's. The candidate CWPPRA project sites typically evidence internal marsh losses. Those losses generally occurred prior to the 1980's and apparently were brought on by the excavation of canal systems. Since then any losses that may have occurred were not measurable.

The type and location of structures to be used would reduce the frequency, direction and duration of communications every managed areas would retain with the unmanged estuary. For the passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or what occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions should also be expected.

The projects in this basin exhibit a complex spatial pattern (Plate 5) consisting of adjacency and captures. The Parish Line of Defense Hurricane Protection Levee alignment would have a significant effect on the hydrology of permitted and proposed project both Gulf-ward and landward that alignment. Landward, the potential exists to have several project areas operating independently of one another, as well as interactively influencing each other, but all subordinate to the operational schedule of the water control structures associated with the hurricane protection levee. The Gulf-ward projects would apparently be cut-off from most all upstream surface freshwater inputs. The operational schedule of some previously permitted projects may have to be modified once they come under the influence of the managed hydrology of nearby or encircling CWPPRA projects.

The management approach taken in this basin suggests that fragmenting the marsh into smaller, and presumably more "manageable," parcels (Plate 5), and reestablishing former and upgrading current management capabilities, are trade-offs perceived to be necessary to prolong the presence and improve the health of the marsh that remains.

5.1.1.5. Vermilion-Teche Basin

Shoreline erosion rates are likely to remain relatively high or even increase along the shoreline where erosion is now occurring. The effects of altered hydrology will likely increase the potential for accelerated loss rates in the marshes north and south of the Intracoastal Canal east of Intracoastal City, and portions of the Paul J. Rainey Wildlife Refuge. Additional future losses may occur near Lake Cock, Hammock Lake, and near Lakes Tom and Sand (Marsh Island) due to shoreline breaching. Altered surface hydrology appears to be a reason to suspected accelerated interior marsh losses between Mud Lake and Bayou Sale including the area near Horseshoe Bend.

5.1.1.5.1. Overview of Basin CWPPRA Projects

Four CWPPRA projects (Plate 6) are assumed to be viable candidates for future implementation (Tables 5-5, 5-11). If

all are implemented they would involve 39,278 acres (Tables 5-5, 5-11, 5-14, 5-15, 5-16, 5-17, and 5-18; Figures 17, 22 and 23).

Two projects intend to slow internal marsh loss rates. One project intends to invigorate existing marsh. One project intends to reacquire/prolong management capability. All four projects have as their second intent the slowing of shoreline erosion rates.

Hydrologic restoration would be the management option of choice for all four projects.

5.1.1.5.2. Profiles of Individual CWPPRA Projects

Project **TV-1** encompasses a 2,181-acre brackish marsh area that has exhibited relatively high shoreline erosion throughout the period of record. Very little internal marsh loss was recorded. Wind-driven waves from prevailing winds is the suspected reason for the erosion. Shoreline erosion is expected to continue. Any internal marsh loss that may have occurred was not be detectable. To mimic historic conditions this actively operated hydrologic restoration project involves installing a solid plug at the mouth of a man-made canal and cutting gaps in one canal embankment to facilitate surface water movement, the installation of two rip-rap plugs in a pipeline canal and the installation of a fixed-crest weir and culvert at the canal end near where a flap-gate would be installed in a bayou. To arrest shoreline erosion, the exposed shoreline would be armored. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **TV-4** encompasses a 30,000-acre fresh marsh area that has exhibited relatively high shoreline and interior marsh loss.
The shoreline losses have occurred throughout the period of record and are expected to continue due to wind-driven waves. Nearly all of the recorded internal marsh loss occurred during the 1930's-1974 time frames. During those same time frames petroleum extraction canal systems were excavated. Those canal systems are suspected of locally retarding surface drainage as well as locally increasing tidal amplitude and scour. Those conditions may persist. To mimic historic conditions this actively operated hydrologic restoration project involves the installation of perimeter structures consisting of low level rock weirs at major waterway opening along the Cote Blanche Bays, and

several one-way flap-gated culverts to control introductions of fresher water and sediments. A shoreline rock bulkhead would be installed to stop shoreline erosion at critical locations. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures or marsh. Freshwater and sediment inputs from the Gulf Intracoastal Waterway would be reduced to pulsed, point-source inputs rather than what they are (i.e., ambient hydrologic happenings through breaches in canal embankments).

Project **TV-5/7** encompasses 6,697-acre brackish marsh area that has exhibited a high rate of shoreline erosion (bay and interior lakes) throughout the period of record. Losses from the excavation of petroleum extraction canals during the 1958-1974 time frame were also recorded. Interior marsh losses have been reported, attributed to the hydrologic effects of the canals, but may be occurring at rates that can't be detected. To mimic historic conditions this passively operated hydrologic restoration project involves rebuilding/armoring portions of the eroded bay-front shoreline, plugging the mouths of the canals and gapping canal embankments to restore internal surface flow patterns. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary at the structures would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures. Nonetheless, the targeted marsh would remain open to undampened tidal influences via a natural bayou.

Project **TV-8** encompasses a 400-acre brackish marsh area that has exhibited high shoreline erosion throughout the period of record due to wind-driven wave action. That situation is expected to continue. A weir once controlled the hydrology of the marsh but it is no longer functional. To mimic historic conditions this actively operated hydrologic restoration project involves replacing the old weir with a variable-crest weir fitted with a vertical slot and the construction of a rock breakwater. The hydrology of the area will be returned to a managed condition. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to whatever could/would occur during those occasions when tides rose to levels that overtopped the structures.

5.1.1.5.3. Teche-Vermilion Basin Summary

Hydrologic restoration would be the only management option

for 87,751 acres of marsh involving fresh and brackish marsh types. Passively operated hydrologic restoration would be implemented on 6,697 acres of the brackish marsh types. Actively operated hydrologic restoration would be implemented on 37,139 acres of fresh and brackish marsh types. Hydrologic restoration is apparently perceived to be conducive to the protection/restoration of several marsh types whether or not the management is active or passive and regardless of the time period during which losses occurred.

Quantitative comparisons between the management of an area and any particular historic time frame are unspecified. However, the tidal signals within all marsh types would be only partially reflective of the tidal signal in the unmanaged portion of the estuary. Reduced tidal signals within managed areas, whether achieved through the application of active or passive measures, are apparently perceived to be conducive to the protection/restoration of several marsh types.

The CWPPRA projects exhibit a disconnected spatial pattern relative to one another. Therefore, it is unlikely that any of the four CWPPRA projects exerts an influence on the other and effects would be site specific. However, one project does partly capture a previously permitted passively managed project and could have an influence on the operation of that project.

5.1.1.5.4. Teche-Vermilion Basin - Future With Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 64,513 acres would be brought under management, 25,235 from permits and 39,278 from candidate CWPPRA projects (Tables 5-14, 5-15, 5-16, 5-17 and 5-18; Figures 17, 22 and 23). The average size of the permitted projects was 2,294 acres. The average size for the CWPPRA projects would be 9,820 acres.

By marsh type, 3,085 acres of fresh marsh (permits - active and passive marsh management), 5,140 acres of fresh/intermediate (permits - active and passive marsh management; CWPPRA - active marsh management), 3,900 acres of intermediate marsh (permits - active marsh management), 12,440 acres of intermediate/brackish marsh (permits - active and passive marsh management), and 5,790 acres of brackish marsh (active and passive marsh management) would be managed.

About 75 % of the permitted project acreage and all of the candidate CWPPRA project acreage encompasses marsh that has evidenced historic marsh losses. The permitted projects

exhibited either historic internal or historic and ongoing shoreline erosion. The candidate CWPPRA projects exhibited historic and ongoing shoreline erosion with some internal marsh losses apparently related to the excavation of canals that caused or accentuated by man's activities.

The type and location of structures to be used would reduce the frequency, direction and duration of communications every managed areas would retain with the unmanged estuary. For the passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or what occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions should also be expected.

5.1.1.6 Delta Basins/Regional Summaries

5.1.1.6.1. CWPPRA

Hydrologic restoration is the management alternative of choice (Figure 17). Hydrologic restoration would encompass 190,788 acres of marsh compared with 77,614 acres of Delta marshes that would be subjected to marsh management. A reduction of tidal expression within managed areas is apparently perceived to be necessary in most cases, regardless of marsh type involved. Only a small number of projects don't amend the ambient tidal regime.

On an acreage basis, about half of the projects encompass only one marsh type, typically brackish (Table 5-17, 5-18 and 5-19; Figures 18 and 19). However, when more than one marsh type is involved, based upon acreage, the fresh and intermediate marsh types are most often included.

At this stage of project development, the connection is not readily apparent between the marsh loss problems and the proposed management solutions for several projects. Subsequent evaluations performed during advanced project design and NEPA compliance reviews should clarify the linkage and may reveal implementable alternative approaches for all projects.

5.1.1.6.2. Future With Permits and CWPPRA

A total of 622,162 acres would be brought under management, 353,760 acres from permits and an additional 268,402 acres from candidate CWPPRA projects (Tables 20, 22 and 23; Figures 22, 24 and 25). The average size of the permitted projects was 7,075 acres and increased to 8,133 acres for candidate CWPPRA projects (Table 5-21, Figure 23).

On an acreage basis, hydrologic restoration would be the more often used management option. Of the candidate CWPPRA projects, hydrologic restoration would encompass 190,788 acres and marsh management would encompass 77,614 acres. Both active and passive hydrologic restoration would be employed. The active form would be used on about 120,000 acres. The passive form would be used on about 75,000 acres. Only in Basin 1 was the acreage of the two forms of hydrologic restoration about equal. In Basins 4 and 7 the active form of hydrologic restoration was more prevalent (by a multiple of about 4).

Appreciable potentials for project interactions and interdependencies, based on spatial patterns, were readily apparent in Basins 4 and 5 (Plates 4 and 5, respectively) and suggested in Basin 7 (Plate 6).

The management approaches taken in Basins 4 and 5 suggest that fragmenting the marsh into smaller, more "manageable" sizes, and reestablishing former and upgrading current management capabilities are trade-offs perceived to be necessary to prolong the presence and improve the health of the marsh that remains. Boundaries to existing and proposed management areas would involve natural and extensive use of existing man-made surface landscape features.

### 5.1.2. Chenier Basins

#### 5.1.2.1. Mermentau Basin

Relatively high shoreline erosion rates are likely to continue along the Gulf and along the shorelines of Grand, White, Sweet and Latina Lakes, as well as Lakes Cullicon and Misere. Altered surface hydrology is suspected to be the reason it's likely losses will continue at relatively high rates in the marshes north of White Lake, south of Pecan Island, near Secon Lake and east of Louisiana Highway 27 near the Intracoastal Waterway.

Shoreline breaches due to wave action could lead to accelerated erosion of marshes near Clear and Catfish Lakes and at several places along the Gulf shoreline.

Altered surface hydrology would be the reason marshes could erode more rapidly in the foreseeable future southeast of Pecan island, due east of White Lake, south of Lake Misere and between White Lake and Freshwater Bayou (south of the Gulf Intracoastal Waterway).

##### 5.1.2.1.1. Overview of Mermentau Basin CWPPRA Projects

Six CWPPRA projects (Plate 7) are assumed to be viable

candidates for future implementation (Tables 5-6 and 5-12, Figures 17, 22 and 23). Collectively, the six projects would encompasses 21,409 acres. However, only one project, encompassing 7,300 acres, would establish a newly managed area.

Five projects intend to sustain and/or enhance productivity of the targeted marshes, including invigorating existing marsh. Collectively, these five projects encompass 14,109 acres. The sixth project intends to enhance productivity and halt erosion.

5.1.2.1.2. Profiles of Individual Mermentau Basin CWPPRA Projects

Projects **PME-14, PME-15, XME-40, XME-45,** and **XME-46** collectively encompass all four marsh types and areas that have exhibited historic marsh losses. Interior marsh losses in the areas encompassed by PME-14, XME-46 were characterized as relatively high. Interior marsh losses in the areas encompassed by PME-15, XME-40 and XME-45 were characterized as moderate. Most of the losses in XME-45 occurred since 1983. Most of the losses in PME-14 occurred during the 1958-1974 time frame. Most of the losses in PME-15, XME-40 and XME-46 occurred during the 1930's to 1974 time frame. Any losses that may have occurred since then in those five areas have generally not been measurable. All five projects involve the installation of water control structures that would upgrade the existing structures and increase/perpetuate the potential to actively manipulate water levels in these managed areas. The frequency, direction and duration of communications these managed areas would retain with the unmanaged estuary would be reduced to what was allowed to occur through the structures and whatever could/would occur during those occasions when tides rose to levels that overtopped the structures, marsh or perimeter embankments.

Project **PME-16** encompasses a 7,300-acre fresh/intermediate marsh area that has exhibited fairly constant but not extensive historic interior marsh loss during the 1930's-1983 time frames. This actively operated marsh management plan would likely involve the installation of variable-crest weirs fitted with flapgated culverts. The hydrology of this project area is already influenced by the operation of several water control structures. The frequency, direction and duration of water movements through the project's structures would mirror the effects of those other structures. Therefore, the communication this managed area would retain with the unmanaged estuary would be reduced to what would/could occur whenever tidal or flood water levels overtopped the structures, the marsh and/or any perimeter

embankments.

### 5.1.2.1.3. CWPPRA - Mermentau Basin Summary

Quantitative comparisons between the results of managing an area and any particular historic time frame are unspecified. All of the marshes encompassed by the CWPPRA hydrologic restoration and marsh management projects exhibited some degree of historic marsh loss for various reasons. Only projects XME-40 and XME-46 encompass marshes where relatively high loss rates may persist, or accelerate (largely due to shoreline erosion).

Actively operated hydrologic restoration and marsh management would be the management options of choice (Tables 5-14, 5-15 and 5-16, Figure 17). Active operation was apparently perceived to be conducive to the protection/restoration of several marsh types regardless of where, when or why the losses occurred or may continue to occur.

PME-14 and XME-40 are adjacent to each other and are located on the same natural waterway (Plate 7). As these two areas are hydrologically differentiated from each other due to existing management operations, they probably don't influence each other and they may no longer exhibit similar hydrologic dynamics. All the other projects exhibit disconnected spatial patterns relative to one another. Except for the two adjacent projects, it is unlikely that any of the four CWPPRA projects exerts any influence on any other CWPPRA projects.

### 5.1.2.1.4. Mermentau Basin - Future With Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 53,331 acres would be brought under management, 46,031 from permits and 7,300 from a single candidate CWPPRA project (Tables 5-20 and 5-21, Figures 22, 23 and 24). The average size of the permitted projects was 3,069 acres

Six candidate CWPPRA projects have been identified (Plate 7). However, five would use active hydrologic restoration to reacquire former or upgrade existing management capabilities. The sixth project would use active marsh management to bring a 7,300 acre parcel under first-time management.

By marsh type, 279 acres of fresh marsh (permits - passive marsh management), 19,230 acres of fresh/intermediate (permits and CWPPRA - active marsh management), 5,524 acres of intermediate marsh (permits - active and passive marsh management), 6,296 acres of fresh/intermediate/brackish

marsh (permit - active marsh management), 8,700 acres of intermediate/brackish marsh (permits - active marsh management), and 13,302 acres of brackish marsh (permits - active and passive marsh management) would be managed.

About 7,000 acres of permitted management did not exhibit much of any measurable marsh loss during the period of record, even though marsh restoration was stipulated as the single project purpose in one case. All other permitted projects and all of the candidate CWPPRA projects exhibited some historic loss.

The permitted and CWPPRA projects exhibited either historic internal (disrupted surface hydrology due to man's activity) and/or historic and ongoing shoreline erosion. Any subsequent loss in the targeted CWPPRA project areas has not been measurable.

The type and location of structures to be used would reduce the frequency, direction and duration of communications every managed areas would retain with the unmanged estuary. For passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or what occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions could and should be expected.

Project patterns in this basin exhibit elements of adjacency, in-fill and capture (Plate 7). The consequences of management are expected to reflect the effects of individual as well as collections of projects.

5.1.2.2. Calcasieu-Sabine Basin

This basin was studied by the United States Department of Agriculture, Soil Conservation Service (now the National Resource Conservation Service) (1993). To facilitate the study, the entire basin was conceptually partitioned into individual management units. Management recommendations were made for each unit. The CWPPRA hydrologic restoration and marsh management plans mirror those study findings. Therefore, the reader is urged to refer to the cited publication for any additional detailed information.

Damages to marshes from hurricanes and flooding events during the period 1955 to 1974 have been noteworthy. Wave and tidal action are suspected of combining to gouge holes in the marsh surface. Water with stressful or toxic levels of saline that were forced inland by the storms didn't drain off fast enough to avoid damaging the more susceptible marsh plants. Over the years, erosion of the shorelines of the

resulting open water areas continued.

Relatively high Gulf shoreline erosion rates are expected to continue. The continuing effects of altered surface hydrology are suspected of being why the mashes between Back Ridge and the south shore of Calcasieu Lake, the West Cove shoreline, the marshes between Mud Lake and the Calcasieu Ship Channel, and the marshes between Hamilton Lake and Starks south Canal will continue to exhibit relatively high erosion rates.

5.1.2.2.1. Overview of Calcasieu-Sabine Basin CWPPRA Projects

Forty-three CWPPRA projects are assumed to be viable candidates for future implementation (Plate 8, Tables 5-7 and 5-13, Figures 17, 20, 23 and 24). Many amount to upgrades or refinements of former or existing management capabilities. Fourteen clearly would bring new areas under management for the first time. A collective total of 206,873 acres of marsh would be brought under management for the first time or a former management capability would be reestablished.

One project has as it's intent the production of more submerged aquatic vegetation. One project has as it's intent the reestablishment of the historic boundary between the Calcasieu and Sabine drainages. Another project would facilitate an on-going marsh expansion. Two projects have as their intent the invigoration of the existing marsh and the reduction of marsh loss. Two other projects would reestablish the hydrologic integrity of formerly managed areas. Four projects have as their intent the protection and invigoration of the existing marsh type (three of which have the production of more SAV as a secondary intent) and two others have the reduction of marsh loss as a goal. Eight projects intend to convert the existing marsh to a fresher marsh type, to include invigorating the existing marsh and/or the production of more SAV. Seven projects would prolong and/or upgrade the existing management capability. Eight projects are intended to invigorate existing marsh and produce more SAV and seven more projects would additionally attempt to vegetate exposable substrates.

5.1.2.2.2. Profiles of Individual Calcasieu-Sabine Basin CWPPRA Projects

5.1.2.2.2.1. East of Calcasieu Lake

Project **PCS-25** encompasses a 650-acre fresh/intermediate marsh area has exhibited relatively high marsh loss, especially during the 1958-1974 time frame. The affects

from shoreline breaches and canals are suspected of being part of the historic land loss problem. Losses in the project area are not expected to accelerate or remain high. To mimic historic conditions this actively operated hydrologic restoration project would involve the installation of new flap-gated culverts, replacement of existing flap-gated culverts and the placement of a solid plug in a shoreline breach. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **CS-14** is estimated to have an area of influence encompassing about 1,186 acres of brackish marsh within a previously permitted project area that encompasses a portion of the Sabine National Wildlife Refuge. The likely area of effect has exhibited relatively high marsh loss throughout the period of record. This project involves the installation of a variable crest, slotted weir fitted with flapgated culverts and the excavation of a small canal to facilitate water exchange with Calcasieu Lake. The intent of the project is to better achieve the management goals of the Cameron-Creole project. This project would not bring any new marsh under management.

Project **CS-10** encompasses a 1,462-acre brackish marsh that has exhibited relatively high marsh loss, especially during the 1958-1983 time frames. Future loss is not expected to remain high or accelerate. This actively operated marsh management plan would involve installation of a rock weir in a bayou, variable-crest weirs fitted with flapgated culverts, rehabilitation of a portion of the perimeter levee to a height of three feet and cutting gaps in an internal embankment. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankments.

5.1.2.2.2.2. West of Calcasieu Lake

5.1.2.2.2.2.1. Southwest Calcasieu Lake

Project **XCS-48(SO-8)** encompasses a 12,600-acre area characterized as brackish marsh. Project **PCS-12/18** encompasses a 7,560-acre portion of the XCS-48(SO-8) project area and is characterized as containing brackish and saline marsh types. The XCS-48(SO-8) project area has exhibited

marsh loss, especially during the 1958-1983 time frames. The effects of increased tidal amplitude and saltwater, related to the Calcasieu Ship Channel, the effects of canals and the effects of storms and several other high water events are all suspected of contributing to the historic marsh loss. Losses in the project area may remain high and may accelerate. To mimic historic conditions these passively operated hydrologic restoration projects would, at a minimum involve the installation of a large weir (design unspecified) in a natural bayou. Implementation of PCS-12/18 would involve the installation of a second weir (design unspecified) in another natural bayou. Under the more constrictive PCS-12/18 project scenario, the frequency, direction and duration of communications even the larger XCS-48(SO-8) project area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures if rock weirs are installed and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or marsh.

Project **XCS-48(SO-5)** encompasses a 12,0007-acre fresh/intermediate marsh that has exhibited relatively high land loss, nearly all of which occurred during the 1958-1974 time frame. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, and possibly storms, are suspected of being part of the historic land loss problem. Losses in the project area are not expected to accelerate. This project would not bring any marsh under management for the first time. However, to mimic historic conditions this actively operated hydrologic restoration project would involve the addition of a variable crest weir to an existing structure. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structure and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or nearby beach rim.

Project **PCS-24** encompasses a 8,054-acre brackish marsh that has exhibited relatively high land loss, nearly all of which occurred during the 1958-1983 time frames. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, canals, and possibly storms, are suspected of being part of the historic land loss problem. Losses in the project area may remain high or even accelerate. This project would not bring any marsh under management for the first time. This actively operated marsh management plan involves perimeter work consisting of the installation of several variable-crest slotted weirs fitted with flap-gated culverts, earthen plugs, ant the

restoration of nearly a mile of existing embankment. The frequency, direction and duration of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structure and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankment.

5.1.2.2.2.2.2. West-Central Calcasieu Lake

Project **XCS-44** encompasses a 6,368-acre brackish marsh that has exhibited relatively high land loss, nearly all of which occurred during the 1958-1974 time frame. The effects of canal construction on tidal fluctuations and a salinity regime that reflects the proximity of the project area to the Calcasieu Ship Channel are suspected of being part of the historic land loss problem. Losses in the project area may remain high or even accelerate. To mimic historic conditions this passively managed hydrologic restoration plans involves the installation of a solid earthen plug at the mouth of the West Cove Canal near the junction with the ship channel. The frequency, direction and duration of communications the northern part of this managed area would retain with the unmanaged estuary would be only little changed as several other exchange points still exist along several thousand feet of interface between the marsh and the ship channel. The frequency, direction and duration of communications the southern part of this managed area would retain with the unmanaged could be quite different. The canal that would be plugged intersects a natural bayou that undoubtedly effects the hydrology of this southern area. The operation of a Sabine National Wildlife Refuge water control structure could also be affected. The canal that would be plugged is the direct hydrologic link between the structure and the ship channel.

Project **XCS-47/48i,j,k,p** would affect an estimated 41,857 acres of intermediate and brackish marsh that has exhibited a relatively high marsh loss. Most of the recorded loss occurred in the northeastern one-third of the project area and nearly all during the 1958-1974 time frame. The targeted marsh once was a closed, managed marsh system. The perimeter structures were breached years ago and were not completely repaired. The effects of restricted drainage caused by the geometry of natural and man-made surface landscape features, canals, the effects of tidal action and salt water in the managed area following breaching of the perimeter structures, and possibly storms, are suspected of being part of the historic land loss problem. The targeted marsh became a controlled hydrologic system again with the recent installation of the Rycade Canal structure (see project CS-2). This actively operated hydrologic

restoration/marsh management project involves the replacement and upgrade of three sets of existing but undercapacity perimeter water control structures. The new structures would allow for greater control of water levels to include water level lowerings.

Project **XCS-46** would effect an estimated 27,453 acres of fresh/intermediate marsh on the Sabine National Wildlife Refuge that has exhibited relatively high marsh loss, especially during the 1958-1974 time frame. The affected marsh would be a part of the western portion of the XCS-47/48i,j,k project area. To mimic the historic condition, this passively operated hydrologic restoration project would involve the installation of a water control structure (design unspecified) in the North Starks Canal. The structure would serve to reduce/eliminate the breach the canal created in the natural boundary between the Calcasieu and Sabine basins. The impacts would be to reduce/eliminate any direct exchange between the two basins via the man-made canal, thereby enhancing the operational capability of the XCS-47/48i,j,k project structures.

Projects **XCS-48(SA-1, SA-1a, SA-1b, and SA-2)** collectively encompass 18,749 acres. Collectively, all four marsh types are represented. All four area are part of the Sabine National Wildlife Refuge and have been managed for years. Water levels in SA-1, SA-1a and SA-1ba are controlled with variable crest weirs, and augmented with pumps in SA-1a and SA-1b. Water levels in the SA-1 are currently influenced by the Rycade Canal structure (project CS-2) and would also be influenced by the XCS-46 structure in North Starks Canal. Water levels in SA-1a and SA-1b are independently controlled but because they are gravity operated, they are influenced by the Rycade Canal and other refuge perimeter structures. SA-2's perimeter embankment has been breached for several years allowing water level control to be accomplished with the structures that would be replaced by project XCS-47/48i,j,k,p. Project area SA-2 has exhibited very little loss during the period of record. Project area SA-1 exhibited loss throughout the period of record but localized losses were recorded in the extreme southwestern portion during the 1930-1954 time frame and more generalized losses throughout the area were recorded during the 1958-1974 time frame. Project areas SA-1a and SA-1b exhibited general loss that occurred principally during the 1958-1983 time frames. Losses were attributed to several causes, including the adverse effects of slow-to-drain saline waters introduced into these areas by hurricanes in 1957 and again in 1961, as well as intentional efforts to open up the marsh as part of the management program. Project SA-01 is classified as a nutrient trapping project but water levels would mimic a managed condition through the manipulation of the Rycade

Canal and other refuge perimeter structures. To mimic a historic condition in the other three project areas these actively managed hydrologic restoration projects would involve the installation of additional structures with which to more site specifically manage water levels and shunt fresher water into the SA-1 project area (SA-1a and SA-1b) and maintenance of the existing perimeter embankment (SA-2). The frequency, direction and duration of communications these areas would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and/or what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankments.

5.1.2.2.2.2.3. Northwest Calcasieu Lake

Project **CS-9** would effect 2,800 acres of brackish marsh that has exhibited relatively high loss, the majority of which occurred during the 1958-1974 time frame. The Alkali Ditch was constructed during the 1930-1954 time frame to provide access to petroleum extraction operations. Increased tidal dynamics and salinity associated with subsequent deepenings of the Calcasieu Ship Channel are suspected of being part of the historic loss problem. This actively operated marsh management project would involve the construction of a perimeter embankment system inclusive of several variable crest weir fitted with flapgated culverts to create the opportunity to conduct water level drawdowns. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the structures or perimeter embankments.

Project **XCS-53** encompasses 14,500 acres, which includes the old Brown Lake and adjoin brackish marsh. Relatively high historic loss was recorded in the project area especially during the 1958-1974 time frame. The Alkali Ditch was constructed during the 1930-1954 time frame to provide access to petroleum extraction operations. Increased tidal dynamics and salinity associated with subsequent deepenings of the Calcasieu Ship Channel are suspected of being part of the historic loss problem. To mimic historic condition this passively operated hydrologic restoration project would involve the construction of a weir (with a boat bay) across the Alkali Ditch where it intersects with the Gulf Intracoastal Waterway. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to occurred over the weir crest and would/could occur during those occasions when tides rose to levels that overtopped the marsh.

Additionally, this structure would influence the hydrology of the CS-5 project area until that project was completed. The Rycade Canal structure, and the area that it influences, would also be influenced by the Alkali Ditch structure.

Projects **CS-8/XCS-48(NO-2, 2a, 4 and 5)** collectively encompass 13,787 acres of intermediate/brackish marsh. All four areas have exhibited relatively high historic loss, almost exclusively during the 1958-1974 time frame. The effects of canal construction on tidal fluctuations, a salinity regime that reflects the proximity of the project area to the Calcasieu Ship Channel, and possibly the effects of storms are suspected of being part of the historic land loss problem. Losses in these project areas may remain high or even accelerate. Areas NO-2 and NO-4 have been under private management for several years. They would bring no new marsh under management. To continue the current management capability of NO-4 and to upgrade the management capability of NO-2, both actively operated marsh management areas, would involve maintenance of the existing perimeter embankments, some structure upgrades and for NO-2 installation of a freshwater input system. To reacquire management capability of NO-2a, this actively operated marsh management plan would involve the reconstruction of the perimeter embankment fitted and the installation of a variable-crest, slotted weir and flap-gated culverts to reestablish a semi-impoundment. To mimic historic conditions in NO-5, a formerly unmanaged area, this passively operated hydrologic restoration plan would involve the installation of water control structures (design unspecified), plugging man-made canals and gapping of the associated canal embankments, as well as some marsh creation with dredged material and vegetative plantings. Depending upon the final operational plans, the hydrology of each area may not be very similar. However, the hydrology of all four areas would be influenced by the Alkali Ditch structure but in different ways. The frequency, direction and duration of communications all four project areas would retain with the unmanaged estuary would be reduced to whatever was presented to and allowed to pass through the project structures after first being influenced by the Alkali Ditch structure and what would/could occur when water depths overtopped the structures and /or the perimeter embankments.

Project **CS-2** encompasses a 10,000-acre fresh/intermediate/brackish marsh. However, other projects will be implemented which would reduce to 4,600 the number of acres ultimately influenced by this structure. Historic marsh losses in the project area have been characterized previously (e.g., see project XCS-48(SA-1). The project has already been completed. To mimic historic conditions this actively operated hydrologic restoration structure involved

the construction of a water control structure fitted with seven culverts and the installation of three culverts under an oil field road to the west. Until the Alkali Ditch structure is installed, this Rycade Canal structure functions as a perimeter affecting the areas described in **XCS-47/48i,j,k,p,** and **XCS-48(SA-1, SA-1a, SA-1b, and SA-2).** With the installation of the Alkali Ditch structure, this CS-2 - Rycade Canal structure would revert to an internal structure. The hydrologic impact would be to diminish the frequency, direction and duration of communication more internal marshes and included project areas would retain with the surrounding unmanged estuary.

Project **XCS-48(NO-8)** is 11,700-acre parcel that encompasses mostly shallow open water and some fresh/intermediate/brackish marsh. This historic fresh marsh area has exhibited relatively high marsh loss (see projects **XCS-47/48i,j,k,p,** and **XCS-48(SA-1, SA-1a, SA-1b, and SA-2)**. Although classified as a CWPPRA sediment trapping implementation of this project would not bring any new marsh under management but would involve the passive operation of variable-crest weirs, maintenance of the perimeter embankment, vegetative plantings and use of wave stilling/sediment trapping devices. The frequency, direction and duration of communications this management area would retain with the unmanaged estuary would be reduced to whatever was presented to and allowed to pass through the project structures after first being influenced by the Alkali Ditch structure and then by the Rycade Canal structure, as well as what would/could occur when water depths overtopped the structures and/or the perimeter embankments.

Project **PCS-14** targets a 2,500-acre parcel. The targeted area is much of the marsh and open water described under project XCS-47/48i,j,k,p, and XCS-48(NO-5). To mimic historic conditions in those interior marshes this project would involve the installation of a weir with a boat bay in Kelso Bayou, a natural waterway, easterly from Louisiana Highway 27. The frequency, direction and duration of communications the targeted interior marshes would retain with the unmanaged estuary would be reduced to whatever could pass over the structure.

The **NO-3** project area has been continuously managed for more than 30 years, apparently with the assistance of pumps. During the 1960's to through a portion of the 1980's the area was managed as a cattle pasture. More recently, the area is managed for waterfowl and freshwater fisheries. This project involves maintaining the existing management capability. No new marsh would be brought under management. The frequency, direction and duration of communications the

targeted interior marshes would retain with the unmanaged estuary would remain whatever passed into the area from pumping, what ever was allowed to pass through the structures and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

Project **CS-5a/12** is a 28,000-acre parcel that encompasses several management units and fresh, intermediate and brackish marsh types. This large scale, passively operated hydrologic restoration project proposes to introduce fresh water into an area that consists of an integrated collection of individually managed marshes (project areas NO-13 through NO-20). The passive and active management operations of the several project areas would attempt to take advantage of the fresh water to mimic historic marsh conditions. Implementation of the several individual projects would involve the rehabilitation and/or upgrade of existing as well as the installation of many new structures.

Project areas **XCS-14, 15 and 17** are 4,200, 621 and 3,300-acre parcels, respectively, encompass both fresh and intermediate marsh vegetation and open water. These historic intermediate (NO-14) and fresh/intermediate marshes (NO-15, 17) have exhibited historic marsh loss, most of which occurred during the 1956-1978 time frame in NO-14 and NO-17 and during the 1968-1984 time frame in NO-15. Exposure to marine processes (from the Calcasieu Ship channel via the Gulf Intracoastal Waterway) is suspected of being part of the historic problem as may be unintentional partial impoundment. Since then, the marshes have appeared to remain stable.

**NO-14** would be a passively operated marsh management area. To bring this marsh under management for the first time would involve the installation of a rock weir in each of the two natural tributaries of Black Bayou that drain the project area, apparently creating a "permeable" (because of the hydrologic characteristics of the rock weir) semi-impoundment. The frequency, direction and duration of communications this interior marsh in a managed configuration would retain with the unmanaged estuary would be reduced to whatever was allowed to move from Black bayou and enter the area through the structures and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

**NO-15** and **NO-17** would be passively operated hydrologic restoration projects. To mimic historic conditions in project area NO-15 a structure (possibly solid plugs) would be placed in each of the two natural waterways and a structure of unspecified design would be placed in a man-

made canal. The frequency, direction and duration of communications this marsh in a managed configuration would retain with the unmanaged estuary would be reduced to whatever exchange occurred between Black Bayou and the area from the south and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments. To mimic historic conditions in project area NO-17 some of the existing embankments would be repaired, a rock weir would be installed in each of two breaches in a man-made canal embankment, and a flap-gated culvert would be installed under a road (that is part of the southern boundary) to discharge (only) into the immediately adjacent unit (NO-18). The man-made canal is a hydrologic "bridge" between the upper portion of Black Bayou and the Gulf Intracoastal Waterway. Under another project scenario, the opening of this canal would be closed, resulting in the two weirs being located near the extreme northern end of a dead end canal that is itself located at the extreme northern end of a natural bayou. Control of the water level in NO-17 would also be affected by the operation of the flap-gated culvert on the southern boundary. The frequency, direction and duration of communications NO-17 would retain in a "permeable" semi-impounded configuration with the Black Bayou and the unmanged portion of the system would be reduced to what would be allowed to occur through/over the rock weirs and/or what would/could occur when water levels rose to elevations that overtopped the perimeter embankments.

Project **NO-13** encompasses a 4,100-acre parcel of predominantly open water and the intermediate marsh type. This historic fresh/intermediate marsh has exhibited marsh loss, nearly all of which occurred during the 1956-1978 time frame. The area is bordered on all four sides by man-made features but breaches in the northern and western boundaries may have occurred over time. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic problem. To mimic historic conditions (i.e., fresh marsh) this passively operated hydrologic restoration project would involve the installation of a solid plugs as well as structure (design unspecified) substitutions in the perimeter embankment system apparently restoring this area to a semi-impounded condition. The frequency, duration and direction of communications this managed area would retain with the unmanaged estuary would be reduced to what was allowed to occur through/over the crest of the new structures and would/could occur during those occasions when tides rose to levels that overtopped the marsh.

5.1.2.2.2.2.4. Northeast Sabine Lake

Project **NO-14a** encompasses a 3,500-acre parcel of fresh and brackish marsh types and open water. This historic intermediate marsh has exhibited relatively little loss. Rather, it has exhibited a change in type in the more western portion to a more brackish marsh type. The area is bordered on three side by man-made features but has always had free exchange with Black Bayou and the south prong of Black Bayou along the entire western boundary. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic problem. To mimic historic conditions (i.e., fresh to intermediate marsh) this passively operated hydrologic restoration project would involve the installation of a rock weir in two of the several natural tributaries of the Black Bayou system that drain the project area. The frequency, duration and direction of communications this managed area would retain with Black Bayou and the unmanaged portion of the Black estuary would be reduced to what occurred through the other unaltered tributary connections, what occurred over the weir crests and would/could occur during those occasions when tides rose to levels that overtopped the marsh.

Project area **XCS-48(NO-18)** encompasses a 4,422-acre parcel of fresh, intermediate and brackish marsh types and open water. This historic intermediate marsh has exhibited relatively little loss during the period of record. Rather, it has exhibited a marsh type changes, most recently to include brackish marsh plant species. The effects on tidal regime and local salinity related to the Calcasieu Ship Channel and the Gulf Intracoastal Waterway, and possibly storms, are suspected to be part of the historic marsh loss problem. To mimic historic conditions (i.e., fresh/intermediate marsh, inputs from NO-17) this passively operated hydrologic restoration project would involve installing rock liners in most of the locations where the area communicates with Black Bayou and installation of a culvert to provide inputs from XCS-48(NO-19). The frequency, duration and direction of communications this interior managed marsh area would retain with Black Bayou and the unmanged portion of the system would be little changed.

Project areas **XCS-19, 20 and 21** comprise the down-stream marsh area of the Black Bayou system. Collectively, they encompass 17,952 acres of marsh vegetation and open water.

Project area **XCS-19** encompasses a 9,667-acre parcel of fresh, intermediate and brackish marsh vegetation types and open water. This historic intermediate marsh has exhibited relatively little loss during the period of record. Rather,

it has exhibited marsh type changes, most recently to include brackish marsh plant species. The effects of localized salinities and winter droughts are suspected to be part of the historic marsh loss problem. To bring this marsh under management (i.e., passively operated hydrologic restoration) for the first time, historic conditions (i.e., fresh/intermediate marsh) would be mimicked by installing rock weirs in one man-made and several natural tributaries to Black Bayou, installing a solid plug in a man-made canal at the Sabine River {apparently creating a "permeable" (because of the hydrologic characteristics of rock weirs) semi-impoundment} and performing internal work to enhance sediment/nutrient retention. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanged portion of the system would be reduced to what would occur through the rock weirs and what could/would occur when storm-driven water levels overtopped the natural and man-made embankments.

Project area **XCS-48(NO-20)** encompasses a 1,700-acre parcel of intermediate and brackish marsh vegetation types and very little open water. This historic brackish marsh has exhibited relatively little loss during the period of record. Rather, it has exhibited a shift towards a fresher marsh type. To bring this marsh under management (i.e., passively operated hydrologic restoration) for the first time, management would focus on converting the existing marsh to a fresh/intermediate mix. That effort would involve the installation of rock weirs in several of the natural tributaries of Black Bayou and assumes that plugging of the man-made canal called for in XME-48(NO-19) would occur. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanged portion of the system would be reduced to what would occur through the rock weirs and could/would occur when storm-driven water levels overtopped the structures and the marsh.

Project area **XCS-48(NO-21)** encompasses a 6,225-acre parcel of the brackish marsh vegetation type and very little open water. This parcel was historically mapped as grazing land and intermediate marsh has exhibited relatively little loss during the period of record. To bring this intermediate/brackish marsh under management (i.e., passively operated hydrologic restoration) for the first time, management would focus on converting the existing marsh types to the fresh and intermediate marsh types. That effort would involve the installation of rock weirs in several of the natural tributaries of Black Bayou and assumes that plugging of the man-made canal called for in XME-48(NO-19) would occur. The frequency, duration and direction of communications this managed marsh area would

retain with Black Bayou and the unmanged portion of the system would be reduced to what would occur through the rock weirs and what could/would occur when storm-driven water levels overtopped the marsh.

5.1.2.2.2.2.5. East-central Sabine Lake

Project area **PCS-10** encompasses a 1,680-acre parcel of the brackish marsh vegetation type and open water. This parcel was historically mapped as fresh/intermediate marsh and has exhibited historic loss and a conversion to the brackish marsh type. Construction of the Sabine River ship channel is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations and collectively causing the recorded marsh loss and type shift. To bring this area under management (i.e., passively operated hydrologic restoration/marsh management) for the first time would involve the installation of weirs (design unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Black Bayou and the unmanged portion of the system would be reduced to what would occur through/over the weirs and what could/would occur when storm-driven water levels overtopped the marsh.

Project **PCS-11** encompasses a 600-acre parcel of the brackish marsh type and relatively little open water. This parcel was historically mapped as intermediate/brackish marsh and has exhibited historic loss and a conversion to the brackish marsh type. Construction of the Sabine River ship channel, preceded by the construction of internal canals, is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations and collectively causing the recorded marsh loss and type shift. To bring this area under management (i.e., passively operated hydrologic restoration) for the first time would involve the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the plugs/weirs and what could/would occur when storm-driven water levels overtopped the marsh. These structures correspond to some of the Sabine Lake-front structures called for as design components of proposed projects for XCS-48(SA-5 and 7).

Project areas **XCS-48(SA-3, 4 and 6)** are part of the Sabine National Wildlife Refuge.

**SA-3** is a 26,356-acre parcel that was historically a solid fresh marsh. An actively operated managed marsh impoundment since 1951, marsh loss and the appearance of the brackish marsh type have occurred. Marsh losses were characterized as relatively high almost all of which occurred during the 1958-1974 time frame. Some of the losses were intentionally induced by management. However, some marsh loss and marsh type conversion were also attributed to hurricane damages in 1957 and 1961. A three-year water level drawdown in the early 1980's expanded the coverage of submerged and floating aquatic vegetation and emergent marsh vegetation. Maintenance of low water levels is attributed to have prolonged that trend. Wind-induced erosion in shallow water and along shorelines and too high water levels are seen as the likely causes of marsh loss within this managed freshwater impoundment in the future. The proposed action is characterized as a sediment trapping project and would involve internal activates that would be expected to locally enhance sediment retention. However, the proposed plan would also involve installation of new and upgrades of existing perimeter water control structures to increase the ability to manipulate water levels in this impoundment. Implementation of this project would not bring any new marsh under management. The frequency, direction and duration of communications this internal, managed impoundment would retain with the unmanaged estuary would be reduced to what was allowed to occur through the water control structures and what would/could occur during those occasions when tides rose to levels that overtopped the perimeter structures.

**SA-4** is a 13,614-acre unmanaged, unimpounded parcel that was historically a predominately fresh marsh with some intermediate marsh type and very little open water. Historic marsh losses in this internal parcel were characterized as relatively high and occurred almost entirely during the 1958-1974 time frame. The effects of the Calcasieu Ship Channel on water levels and salinity regimes were identified as suspected reason for part of the marsh loss problem. Hurricanes were not identified as source of marsh loss or damage. Wind-induced erosion in shallow water and along shorelines are seen as the likely causes of marsh loss within this managed freshwater impoundment in the future.

**SA-6** is a 2,000-acre unmanaged, unimpounded parcel that was historically a solid fresh marsh. Historic marsh losses in this internal parcel were characterized as relatively high and occurred almost entirely during the 1958-1974 time frame, but more exactly between the mid-1950's and the late 1960's. The effects of the Calcasieu and Sabine Ship Channels on water levels and salinity regimes were identified as suspected reasons for part of the marsh loss

problem. Hurricanes were not identified as source of marsh loss or damage. A shift towards a more intermediate marsh type has apparently occurred and emergent marsh is reported to have reappeared in some portions during the 1980's. Wind-induced erosion in shallow water and along shorelines and the transport of mobilized sediments through breaks in embankments into adjoin man-made canals are seen as the likely causes of marsh loss within this parcel.

Project areas SA-4 an SA-6 historically could have been influenced by both Black Bayou (to the north and west) as well as Johnson's Bayou (to the west southwest). However, the network of man-made canals has accelerated water movement and possibly even rerouted water movements unintentionally. Water moves to and from these two internal marsh parcels via those man-made waterways. Thus, management actions that affect the frequency, direction and duration of water movements within the man-made canals that communicate with these two internal marsh parcels will also affect the hydrology of the parcels as well. In addition to the installation of some structures (e.g., rock weirs) to site-specifically amend the hydrology of the targeted marshes, actions taken to amend the hydrology of the man-made waterways for other project ares with also affect SA-5 and SA-6. And that expectation was noted and has been factored in as part of the management expectations for these two internal marsh areas. Thus, the frequency, direction and duration of communications these two internal parcels would retain with the unmanaged estuary would be reduced to what was allowed to occur through/over the water control structures located elsewhere as well as what occurred through the rock weirs and what would/could occur during those occasions when tides rose to levels that overtopped the marsh.

Project area **XCS-48(SA-5)** encompasses a 23,100-acre parcel of the intermediate and brackish marsh types and open water that is also part of the Sabine National Wildlife Refuge. This parcel was historically mapped as fresh and intermediate marsh with little open water but has exhibited historic marsh loss characterized as relatively high, most of which occurred during the 1958-1974 time frame. More recently, an increase in the amount of the brackish marsh type vegetation, accompanied by the reappearance of emergent vegetation at some sites, was reported. Construction of the Calcasieu River and Sabine River ship channels, preceded by the excavation of internal canals and the construction of cattle walkways, is suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations, thereby collectively causing the recorded marsh loss and marsh type changes. More recently, an increase in the amount of the brackish

marsh type vegetation as well as the reappearance of emergent vegetation in some areas was reported. To bring this area under management (i.e., passively operated hydrologic restoration) for the first time to mimic a historic condition would involve perimeter structure work to include the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system (see Project PCS-11), the installation of operable water control structures and the plugging of man-made waterways. Collectively, the proposed work may convert this area to a semi-impounded area. If not, the frequency, duration and direction of communications this newly managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the plugs/weirs, any stabilized breaches that communicate with the internal canal system, and what could/would occur when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SA-7)** encompasses a 5,610-acre parcel of the intermediate and brackish marsh types and open water that is also part of the Sabine National Wildlife Refuge. This parcel was historically mapped as intermediate and brackish marsh with little open water but has exhibited historic marsh loss characterized as relatively high, most of which occurred during the 1958-1974 time frame, more exactly during the 1950's-1960's time frame. Even more recently, an increase in the amount of the brackish marsh type vegetation, accompanied by the reappearance of emergent vegetation at some sites, was reported. Construction of the Calcasieu River and Sabine River ship channels, preceded by the excavation of internal canals and creation of embankments, are suspected of elevating salinities and operation of the Toledo Bend Reservoir is suspected of increasing water level fluctuations and contributing to waterlogging of the soils, thereby collectively causing the recorded marsh loss and marsh type changes. More recently, an increase in the amount of the brackish marsh type vegetation as well as the reappearance of emergent vegetation in some areas was reported. To apparently bring this area under management (i.e., actively operated hydrologic restoration) for the first time to mimic a historic condition would involve perimeter structure work to include the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system (see Project PCS-11), the installation of operable water control structures and the plugging of man-made waterways. The proposed work may convert this area to a semi-impounded area. If not, the frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be reduced to what would occur through/over the perimeter

plugs/weirs, any stabilized breaches (in a portion of perimeter embankment) that communicate with the internal canal system, and what could/would occur when storm-driven water levels overtopped the structures, embankment and marsh.

5.1.2.2.2.2.6. Southeast Sabine Lake

Project area **XCS-48(SO-1)** encompasses a 30,585-acre parcel of the intermediate and brackish marsh types with relatively little open water. This parcel was historically mapped as intermediate and excessively drained saline marsh. The parcel was characterized as stable marsh with little loss. To apparently bring this area under management (i.e., passively operated hydrologic restoration) for the first time to mimic a historic condition would involve the installation of plugs/weirs (designs unspecified) in natural and man-made waterways that communicate with the Sabine River system. The frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be largely reduced to whatever natural drainage would occur between the main stems of the natural bayous as well as what could/would occur through/over the plugs/weirs and when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SO-1a)** encompasses a 3,950-acre parcel of the intermediate and brackish marsh types with relatively little open water. This parcel was historically mapped as brackish marsh. The parcel was characterized as stable marsh with very little loss. The parcel apparently drained through sheet flow as their are no natural surface water drainage ways observable. The parcel has been under management. To mimic and prolong the historic situation involves upgrading the water control structures and maintaining the perimeter embankment. The frequency, duration and direction of communications this managed marsh area would retain with Sabine Lake would be largely remain that which could/would occur when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SO-2)** is a 23,763-acre parcel. It contains some areas of intermediate, brackish and saline marsh types. The wetland areas were historically mapped as excessively drained saline marsh. The marsh areas occur within an apparently continuous perimeter embankment. The marsh areas were characterized as stable with very little loss. To mimic the historic situation would involve installation of a water control structure (design unspecified). The frequency, duration and direction of communications the managed marshes in this parcel would retain with Sabine Lake would largely remain that which

could/would occur when storm-driven water levels overtopped the structures and marsh.

Project area **XCS-48(SO-4)** encompasses 6,800-acre parcel of the intermediate marsh types with relatively little open water. This parcel was historically mapped as brackish marsh. The parcel was characterized as stable marsh with very little loss but signs of and the potential for future losses were noted due to altered hydrology. To implement the proposed upgrade of an actively operated marsh management project would involve maintenance of the perimeter embankment, upgrading the in-place water control structure, and installation of a variable crest weir fitted with a flap-gated culvert. The project area would continue to be an actively managed semi-impoundment. Thus, the frequency, direction and duration of communications this internal, managed area would retain with the unmanaged estuary could be increased to what was allowed to occur through additional water control structures, depending upon the operational plan (unspecified), and what would/could occur during those occasions when tides rose to levels that overtopped the structures or the dredged material embankment.

5.1.2.2.3. CWPPRA - Calcasieu-Sabine Basin Summary

These generally fresh to intermediate marshes with little open water in their unaltered condition were located between the Pleistocene prairie formation to the north, the natural Gulf beach rim to the south and between and lateral to two tidally influenced lakes. Apparently, there was no discernible landscape feature that separated the two drainages.

Water as upland run-off or retained rainfall probably moved through the marshes primarily as slow-moving sheets and always in response to gravity and horologic differentials between the two lake systems but often in response to the influence of the prevailing winds. We can only speculate at the complexities of the relationships that must have existed between where water entered theses marshes, how long it was retained in these marshes, where it moved and where water subsequently exited.

Today, and as reflected by the CWPPRA projects, the basin is clearly envisioned as segmented into two major components. One component is the marsh complex that occurs between Sabine and Calcasieu Lake. The other is the marsh complex that lies to the east of Calcasieu Lake.

The vast majority of the marshes east of Calcasieu Lake, until very recently, were not subjected to management,

except on a very localized and limited basis. The landscape and waterways were comparatively unaltered.

The marshes between the lakes exhibit a different history. The eastern half, west central and southwestern portions of those marshes have been under management or the landscape and natural waterways had been extensively reconfigured years ago into a geometrically symmetrical network of marsh units bounded by canals and embankments. The marshes that comprise the northwestern quadrant (essentially the entire Black Bayou system) exhibit much less surface and waterway modification.

The history of the marshes in the northwestern quadrant and the Cameron-Creole marshes may be evidence of how quickly and in what ways marshes tolerant of moderate to low levels of salt respond to unintentional modifications of salinity and tidal dynamics when the hydrology of the system is abruptly changed (deepening of the Calcasieu and Sabine Ship Channels), even if the changes are transmitted through unaltered, natural waterways.

The remainder of the marshes between the lakes, as well as some areas east of Calcasieu Lake, that have been partitioned into units, and many are protected by embankments, are not immune from undergoing marsh loss.

The basin-wide marsh loss during the 1958-1974 time frame is powerfully suggestive, if not conclusive evidence, that some basin-wide change(s) had or were occurring. However, losses simultaneously occurring in both managed and unmanged areas only complicates efforts to determine the individual or interactive effects of hurricanes in 1957 and 1961 and the deepening of the Calcasieu Ship Channel from feet deep to feet deep (19 ).

Implementation of the CWPPRA hydrologic restoration and marsh management plans for this basin:

1) would bring the entire marsh system between the lakes under some form of management;
2) would bring much of the remaining unmanaged marsh along the western and southern rims of Calcasieu Lake under some form of management;
3) would increase the management capability of nearly all of the already managed area; and,
4) could result in the structures controlling the hydrology of some managed units being located behind a series of other structures.

Hydrologic restoration would be the management option of choice for 200,416 acres involving all four marsh types.

Passively operated hydrologic restoration would be implemented on 90,764 acres encompassing all four marsh types. Actively operated hydrologic restoration would be implemented on 38,050 acres encompassing the fresh, intermediate and brackish marsh types.

Marsh management would be the management option of choice for 6,457 acres encompassing all four marsh types. Passively operated marsh management would be implemented on 4,200 acres encompassing the fresh and intermediate marsh type. Actively operated marsh management would be implemented on 2,257 acres encompassing the brackish and saline marsh types.

Hydrologic restoration is the management option of choice and along with marsh management are apparently perceived to be conducive to the protection/restoration of all four marsh types whether or not the management is active or passive and regardless of the time period during which marsh losses occurred.

Quantitative comparisons between the management of an area and any particular historic time frame are unspecified.

Tidal signals within all managed marsh types would be only partially reflective of the tidal signal in the unmanaged portion of the estuary. Reduced tidal signals within managed areas, whether achieved through the application of active or passive measures, are apparently perceived to be conducive to the protection/restoration of several marsh types.

5.1.2.2.4. Calcasieu-Sabine Basin - Future With Permits and CWPPRA Marsh Management/Hydrologic Restoration Projects

A total of 299,353 acres would be brought under management, 92,480 from permits and 206,873 from candidate CWPPRA projects (Tables 5-14, 5-15, 5-17 and 5-20; Figures 17, 22, 23 and 24). The average size of the permitted projects was 8,407 acres (Table 5-21). The average size for the CWPPRA projects would be 7,662 acres (Table 5-21).

By marsh type, 2,000 acres of fresh marsh (CWPPRA - active hydrologic restoration), 53,585 acres of fresh/intermediate marsh (permits - active hydrologic restoration, CWPPRA - active and passive hydrologic resonation), 20,962 acres of intermediate marsh (CWPPRA - active marsh management and active and passive hydrologic restoration), 114,084 acres of intermediate/brackish marsh (51,000 acres of brackish marsh (permits - active marsh management, CWPPRA - passive hydrologic restoration), 66,000 acres of

intermediate/brackish/saline marsh (permits - active marsh management), and 7,224 acres of brackish/saline marsh (permits- active marsh management) could be managed.

Every permitted project area encompasses marsh that exhibited historic loss but only one permit was issued specifically for marsh restoration. Candidate CWPPRA projects also typically encompass areas that have exhibited historic losses. All losses predominantly occurred during the 1958-1983 time frames. Measurable losses since then have not generally occurred, except in a few locations, encompassed by candidate CWPPRA projects, where there appears to be a potential for losses to accelerate. Historic and potential future losses were/are attributed to interrupted surface flow patterns and salinity and tidal modifications brought on by man's activities.

The type and location of structures to be used would reduce the frequency, direction and duration of communications every managed areas would retain with the unmanged estuary. For the passively managed areas, that reduction would tend to be what was designed or allowed to occur through structures or what occurred over structures when tides rose to levels that overtopped the structures or the marsh. In the actively managed areas, more intensive largely seasonal interruptions should be expected. CWPPRA project designs rely heavily upon rock weirs as control structures.

Project patterning in this basin is the most complex of all the basin. Nearly every marsh/pond acre of the basis would be brought under management. Marsh fragmentation, reducing the entire basin into smaller, presumably more "manageable" marsh units, to include reestablishing former and upgrading current management capabilities, are trade-offs perceived to be necessary to prolong the presence and improve the health of the marsh that remains. Boundaries to existing and proposed management areas would involve natural and extensive use of existing man-made surface landscape features. Nearly the entire western half of the basin would be brought under management for the first time. Some managed areas would be located within larger managed areas and/or dependent upon flows elsewhere for exchange. Therefore, the consequences of management are expected to be basin-wide and even more biologically, socially and economically intensive than the expected consequences from management in Basin 4 (Barataria) and Basin 5 (Terrebonne).

5.1.2.3. Chenier Basins/Regional Summary

5.1.2.3.1. CWPPRA

Even with the expanded base of information available in the

Calcasieu-Sabine Basin Plan (NRCS 1992), at this stage of project development, the connection is not readily apparent between the marsh loss problems and the proposed management solutions for several projects. Subsequent evaluations performed during advanced project design and NEPA compliance reviews should clarify the linkage and may reveal implementable alternative approaches for all projects.

Hydrologic restoration is the management alternative of choice. Hydrologic restoration would encompass 200,416 acres of marsh of different types compared with 13,757 acres of Chenier marshes that would be subjected to marsh management. A reduction of tidal expression within managed areas is apparently perceived to be necessary in most cases, regardless of marsh type involved. Only a small number of projects don't amend the ambient tidal regime.

Most projects encompass only two or more marsh type, typically brackish (Figure 20). However, when more than one marsh type is involved, based upon acreage, the fresh and intermediate marsh types are most often included (Figure 20).

5.1.2.3.2. Future with Permits and CWPPRA

A total of 352,684 acres would be brought under management, 138,511 acres from permits and an additional 214,173 acres from candidate CWPPRA projects (Tables 5-20, 5-21 and 5-22; Figure 22, 23 and 24). The average size of the permitted projects was 5,327 acres and increased to 7,649 acres for candidate CWPPRA projects.

On an acreage basis, hydrologic restoration would be the more often used management option. Of the candidate CWPPRA projects, hydrologic restoration would encompass 200,416 acres and marsh management would encompass 13,757 acres. Both active and passive hydrologic restoration would be employed. The active form would be used on about 120,000 acres. The passive form would be used on about 75,000 acres.

Appreciable potentials for project interactions and interdependencies, based on spatial patterns, exist in Basin 8 (especially in the area bounded by the Gulf of Mexico to the South and Louisiana Highway 82)

The management approaches taken in Basins 8 and 9 suggest that fragmenting the marsh into smaller, more "manageable" sizes, and reestablishing former and upgrading current management capabilities are trade-offs perceived to be necessary to prolong the presence and improve the health of the marsh that remains.

### 5.1.3. Coastwide Summaries

#### 5.1.3.1. CWPPRA

Without regard to marsh type or hydrologic regime, each project site targets a fragment of Louisiana's coastal marsh system. The intent of every marsh management project and most of the hydrologic restoration projects appears to be to make the targeted area physically and hydrologically unique from the rest of the unmanged system.

Most projects are designed to reduce the tidal influence within the managed area. Only a very few projects would/could achieve their management goals by not modifying the ambient tidal regime.

Some project sites would be managed more intensively than others. The depth and duration of the flooding regimes of areas where the ambient tidal regime would be modified could be operated independently of each other with the greatest potential for departure from ambient conditions in actively operated areas.

The spatial relationship between some projects in the Barataria (Basin 4) and Terrebonne Basins (Basin 5), and nearly all of the projects in the Calcasieu-Sabine Basin (Basin 9), could effect the operation of one project or several projects could have effects on several to many other project areas. In the other basins, the likelihood of CWPPRA hydrologic restoration and marsh management projects cross-influencing each other is far less (e.g. Mermentau Basin - Basin 8) to probably none (e.g., Pontchartrain Basin - Basin 1; Teche-Vermilion Basin - Basin 7). Consequently, in basins 1, 7 an 8, effects are more likely to be specific to the project site or the very immediate vicinity.

In every case the CWPPRA-expected results of the referenced hydrologic restoration and marsh management projects are represented in terms of project-induced general differences from existing conditions but never in terms of any specific historic condition or future condition. However, because there is no benchmark historic situation stipulated for any CWPPRA project, there is no way to precisely gauge how much restoration any CWPPRA project is expected to achieve except professional opinion. Thus, project-by-project approximations of predicted differences between the with and without management condition for each targeted marsh became the standard for comparison.

Hydrologic restoration is clearly the management option of choice coastwide for future projects. That trend holds true without regard for marsh type. On an acreage basis, about

as much area would be encompassed by projects that encompass only one marsh type as encompass multiple marsh types. The intermediate marsh type is always included in projects that encompass more than one marsh type.

5.1.3.2. Future With Permits and CWPPRA

Louisiana's coastal marshes consist of about 4,500,000 acres of vegetated soils and shallow open water. A total of 974,846 acres of vegetated surface and shallow open water could be under management in the foreseeable future - 492,271 existing managed acres from permit actions and an additional 482,575 acres from candidate CWPPRA projects (Table 5-20, Figures 24 and 25). Between permitted and candidate CWPPRA projects nearly 20 % of Louisiana's coastal marsh/open water complex would be brought under management. The actual acreage under some form of management would probably be even greater because none of the acreage associated with managed Federal, state and private areas, as well as areas brought under management prior to the need for any permits, has been included.

Existing man-made surface landscape features are commonly incorporated into projects. Using them is a common practice because doing so probably dramatically reduces project costs and they are often conveniently aligned along property boundaries, complimenting other interests as well. Where such features don't exist or natural features are lacking, more such features are created to facilitate project design and implementation. Thus, the average size of permitted and candidate CWPPRA projects, often their geometrical shape, and the inclusion of more than one marsh type (and certainly more than one marsh type in many of the projects in Basins 4, 5 and 7) in both permitted and candidate CWPPRA management projects is probably a reflection of these realities.

The result is that CWPPRA would continue, and in Basin 5 and especially Basin 9, accentuate the trend evidenced in the previously permitted projects, to partition unmanaged marsh into smaller, artificially bounded and independently managed units, sometimes one within or under the influence of another. A possible consequence would be to further disrupt the hydrology of the remaining unmanaged marsh.

The average size of the permitted projects was 6,477 acres and increased to 7,911 acres for candidate CWPPRA projects. Project size, and thus the size of the managed marsh, would increase with the implementation of candidate CWPPRA projects.

On an acreage basis coastwide, previously permitted projects

encompass more than one marsh type (349,228 acres of 492,271 permitted acres - 71%). For candidate CWPPRA projects there is more of an emphasis on including only one marsh type within a project (232,790 acres of 482,575 candidate acres - 48%) (Tables 5-17 and 5-23, Figures 25 and 26).

CWPPRA would shift the focus more to the intermediate and brackish marsh types. Candidate CWPPRA projects that would encompass the intermediate only, intermediate/brackish and brackish only marsh types account 69 % (353,530 acres) of the candidate project acres (Figure 25). Only 28 % of the previously permitted projects encompass those same marsh types (139,842 acres) of the total permitted acres.

Marshes currently managed or targeted for management under CWPPRA typically exhibit mostly historic rather than on-going marsh losses. More often than not, recorded losses were associated with man's activities and occurred mostly prior the mid-1980's. Areas likely to continue to exhibit high loss rates or areas with the potential for accelerated losses do occur. Shoreline erosion is another form of historic and on-going erosion targeted, especially erosion of shorelines of larger ponds, and more so in CWPPRA than in permitted projects. Unlike previously permitted projects, most candidate CWPPRA projects include site specific installation of shoreline erosion control features to combat shoreline erosion.

Coastwide, CWPPRA would include an appreciable marsh management option (91,371 acres, Table 5-15). The hydrologic restoration option would seem to have wide applicability. Specifically, hydrologic restoration would be the management option of choice for bringing 391,204 acres of formerly unmanged marsh under management, both actively and passively. Hydrologic restoration would also be the management option of choice for reestablishing former or upgrading existing actively management efforts, some of which were/are marsh management projects.

Overall, all projects can be expected to favorably affect conditions that are conducive to the growth of submerged aquatic vegetation. Shoreline erosion rates of ponds should generally diminish, especially when wave reduction structure are used. The affect of management on the rate exposed shorelines eroded would be related to the durability of perimeter structures. The affect of management on the rate at which any internal marsh losses (for reasons other than dredging) may be occurring remains to be determined. However, the potential to slow loss rates would be higher where measurable losses are currently occurring or are anticipated to occur. Nonetheless, somewhat fresher salinity conditions would be conducive to invigorating

existing marsh but the degree to which the response depends upon that single factor in any particular situation remains to be determined.

## 5.2. **Effects On Significant Resources**

Table 5.20 is a self-guiding presentation of the effects of undertaking management in coastal Louisiana on the previously identified Significant Resources. Recalling that Table 4.1. compared the two principal management options (i.e., marsh management and hydrologic restoration), Table 5.20 stipulates the reasonable foreseeable cumulative of undertaking management in the several coastal Louisiana Basins, the Delta and Chenier Regions of coastal Louisiana as well as coastwide.

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASIN, REGIONS AND COASTWIDE

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **EMERGENT VEGETATION ON UNERODED, NATIVE SOILS**<br><br>Of progressively greater interest to managers intent upon forestalling marsh loss, of increasing general interest in role related to forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>HYDROLOGY: Flooding Frequency, Sediments,<br><br>MARSH SOILS: Surface Elevation, Composition, Water Depth, Persistence<br><br>HYDROLOGY: Velocity, Water depth<br><br>Species Assemblages<br><br>Production | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>*As a function of position*<br><br>1) Basins 1, 2, 4, 5, 7 - Nearly all management efforts, regardless of purpose(s), encompassed marshes with some degree of historic losses (more often than not correlated with man's activities). Considerably fewer projects encompassed areas with a perceived potential for future loss.<br><br>2) Basin 4 - Inter-project influences on Important Attributes possible; could restrict management flexibility/limit response to management<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of enhancing/expanding this significant resource for erosion control, and/or other purposes<br><br>2) Basin 1, 4, 5 and 7 -<br><br>Most areas that would be brought under management have exhibited internal marsh losses, or are exhibiting shoreline erosion<br><br>**DELTA REGION**<br><br>***Historic***<br><br>Only in Basin 4 has management been pursued on a scale suggesting potential significance independent of the response to management | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>See also **DELTA BASINS AND REGION**<br><br>*As a function of position*<br><br>Basins 8 and 9 - Nearly all management efforts, regardless of purpose(s), encompassed marshes with some historic losses; considerably fewer projects encompassed areas with a perceived potential for future loss<br><br>2) Basin 8 - Inter-project influences on Important Attributes possible in one permit grouping; could restrict management flexibility/limit response to management<br><br>3) Basin 9 - Inter-project influences on Important Attributes have already occurred<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes; in most cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>2) Basins 8 and 9- Most or all targeted areas have exhibited historic internal and/or shoreline losses; future shoreline and/or internal losses are anticipated | Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond as intended to management for at least one growing season<br><br>However, adequately or even partially documented monitoring reports characterizing the actual effect of management on targeted acreage/erosion rate too few in number to be considered representative<br><br>***Historic***<br><br>1) Considerably more projects targeted marshes exhibiting historic losses than have or will affect areas of higher potentials for future loss<br><br>2) Generally poor monitoring compliance -<br><br>a) has and will continue to hinder ability to detect/characterize normal variation and to react appropriately to real differences or explain range of responses to management efforts<br><br>b) prolong dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue the merits of each management action<br><br>***Future***<br><br>1) Considerably more projects target marshes exhibiting historic losses than have or will affect areas of higher potentials for future loss<br><br>2) Improved potential for addressing past losses and forestalling future losses<br><br>3) Remains to be determined if differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **EMERGENT VEGETATION ON UNERODED, NATIVE SOILS** (Continued) | ***Future***<br><br>In Basin 5, and possibly in Basin 4, a significant commitment to management has been made as the principal way to affect emergent vegetation on uneroded, native soils on a large scale | **CHENIER REGION**<br><br>***Historic***<br><br>Only in Basin 9 has management been pursued on a scale suggesting potential significance independent of the response to management<br><br>***Future***<br><br>In Basin 9 a significant commitment to management has been made as the way to affect emergent vegetation on uneroded, native soils on a large scale | 4) Past and future research, report and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree, if any, invigorating emergent vegetation on uneroded, native soils contributes to forestalling marsh losses<br><br>5) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management approach that has promise but has yet to be proven generally effective in the long-term in stopping or reversing erosion<br><br>6) If successful, that commitment could encompass a substantial percentage of the remaining emergent vegetation on native, uneroded soils by the year 2015 than it would today in coastal Louisiana<br><br>7) As surrounding unmanaged marshes undergo natural succession/erosion, management efforts will likely have to intensify in targeted marshes where it was judged necessary or prudent to repetitively reduce soil water levels/expose marsh substrates and/or seasonally manipulate pool stages to perpetuate a particular plant community composition<br><br>8) Research, an unforeseen wave of voluntary compliance or significantly more follow-up by NOD would probably be required to acquire data to track/compare differences between historic and future management efforts and to comprehensively characterize responses to management |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **EMERGENT VEGETATION ON EXPOSABLE, ERODED SOILS**<br><br>Of general interest and particular interest to managers intent upon forestalling marsh loss and improving habitat for some species targeted for management; evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>HYDROLOGY: Flooding Frequency, Water Depth, Sediments, Velocity<br><br>MARSH SOILS: Surface Elevation, Water Depth, Composition, Persistence<br><br>Species Assemblages<br><br>Production | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of enhancing/expanding this significant resource for erosion control, and/or other purposes<br><br>*As a function of position*<br><br>1) see above<br><br>2) Basin 4 - Inter-project influences on Important Attributes possible; could restrict management flexibility/limit response to management<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>2) Basin 1, 4, 5 and 7 - most areas that would be brought under management have exhibited internal marsh losses, or are exhibiting shoreline erosion<br><br>**DELTA REGION**<br><br>*Historic*<br><br>Attempts to affect this resource could encompass up to as much as 55 % (192,000 acres) of the total acres brought under management, suggesting a potential for significance independent of the response to management | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>*As a function of position*<br><br>See Delta Basins/Region; also, in Basin 9 inter-project influences on Important Attributes have already occurred; in most cases, with the intent of invigorating/expanding this significant resource for erosion control, and/or other purposes<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of enhancing/expanding this significant resource for erosion control, and/or other purposes<br><br>2) Basins 8 and 9- Most or all targeted areas have exhibited historic internal losses attributed to man's activities and/or shoreline losses; site-specific future shoreline and/or internal losses are anticipated<br><br>**CHENIER REGION**<br><br>*Historic*<br><br>A significant commitment to management has occurred in both basins; precisely how much is subjected to management targeting this significant resource is unknown. | Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond as intended to management for at least one growing season<br><br>However, complete or even partially documented reports characterizing how this significant resource responded to management are too few in number to be considered representative<br><br>*Historic*<br><br>1) Considerably more projects targeted marshes exhibiting historic losses than have or will affect areas of higher potentials for future loss<br><br>2) Generally poor monitoring compliance -<br><br>a) have and will continue to hinder ability to detect/characterize normal variation and to react appropriately to real differences or explain range of responses to management efforts<br><br>b) prolong dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue merits of each management action<br><br>*Future*<br><br>1) The potential for addressing past losses and slowing, stopping or reversing future losses directly increases by management affecting this significant resource<br><br>2) Remains to be determined if differences between managed areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **EMERGENT VEGETATION ON EXPOSABLE, ERODED SOILS** (Continued) | ***Future***<br><br>A significant commitment to management has been made in all but Delta Basin 2, but how many acres will ultimately be subjected to efforts that would affect this significant resource remains to be determined | ***Future***<br><br>A significant commitment to management has been made in Basin 9, but precisely how many additional acres would ultimately be subjected to efforts that would affect this significant resource remains to be determined | 3) Past and future research, report and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree, if any, inducing emergent vegetation to grow on exposable, eroded marsh soils contributes to forestalling marsh losses<br><br>4) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management approach that has promise but has yet to be proven generally effective in the long-term in stopping or reversing erosion<br><br>5) If successful in the long-term, that commitment could encompass a substantially greater percentage of the remaining emergent vegetation on exposable, eroded soils by the year 2015 than it would today<br><br>6) As surrounding unmanaged marshes undergo natural succession/erosion, management efforts will likely have to intensify in targeted marshes where it was judged necessary or prudent to repetitively reduce soil water levels/expose marsh substrates and/or seasonally manipulate pool stages to perpetuate the vegetation induced to grow on exposable soils<br><br>7) Research, an unforeseen wave of voluntary compliance or significantly more follow-up by NOD would probably be required to acquire data to track/compare differences between historic and future management efforts and to comprehensively characterize responses to management |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **MARSH PONDS/OPEN WATER AREAS**<br><br>Of interest to managers intent upon forestalling marsh loss (primary) and/or improving habitat for species targeted for management (secondary); evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br><u>Size</u><br><br><u>Depth</u><br><br><u>Interspersion</u><br><br><u>Persistence</u> | ~BASIN-BY-BASIN: Permitted Projects<br><br>*As a function of acreage*<br><br>Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of controlling erosion and/or other purposes<br><br>see also COASTWIDE<br><br>*As a function of position*<br><br>See also COASTWIDE<br><br>BASIN-BY-BASIN: CWPPRA Projects<br><br>Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, intentionally and/or unavoidably affecting this significant resource, thereby unavoidably affecting this significant resource; with the intent of controlling erosion and/or other purposes<br><br>DELTA REGION<br><br>***<u>Historic</u>***<br><br>Attempts were made to halt or control the expansion of this significant resource<br><br>***<u>Future</u>***<br><br>A significant commitment to management has been made in all but delta Basin 2, but how many acres will ultimately be subjected to efforts designed to affect this significant resource remains to be determined | BASIN-BY-BASIN: Permitted Projects<br><br>*As a function of acreage*<br><br>Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of controlling erosion and/or other purposes<br><br>See also COASTWIDE<br><br>*As a function of position*<br><br>See also COASTWIDE<br><br>BASIN-BY-BASIN: CWPPRA Projects<br><br>Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of controlling erosion and/or other purposes<br><br>DELTA REGION<br><br>***<u>Historic</u>***<br><br>Attempts were made to halt or control the expansion of this significant resource<br><br>***<u>Future</u>***<br><br>A significant commitment to management has been made in all but delta Basin 2, but how many acres will ultimately be subjected to efforts designed to affect this significant resource remains to be determined | Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond as intended to management for at least one growing season<br><br>However, complete or even partially documented reports characterizing how this significant resource responded to management are too few in number to be considered representative<br><br>***<u>Historic</u>***<br><br>1) Impressions of responses to management are typically derived from aerial photographs, insights, opinions and inferences from literature;<br><br>2) Continued reliance on those information sources is expected to continue to hinder efforts to define problems, design solutions, serve as a basis for arguing the merits of proposed/on-going management efforts, detecting/characterizing normal variation, and to reacting appropriately to real differences or explaining the range of responses to management efforts<br><br>***<u>Future</u>***<br><br>1) The potential to slow, stop or halt the expansion of this significant resource increases through management actions<br><br>2) Remains to be determined if differences between managed areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **MARSH PONDS/OPEN WATER AREAS** (Continued) | | | 3) Past and future research, aerial photographs, reports and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will continue to be the sources of readily available information<br><br>4) Collectively, historic and future management initiatives represent a significant commitment of acreage comprised of this resource; often brought under management for reasons in addition to erosion control; other erosion control options are often available<br><br>5) If successful, that commitment could encompass a substantial percentage of the stabilize marsh ponds/open water areas in coastal Louisiana by the year 2015, perhaps even a greater percentage than it would represent today<br><br>6) Research, an unforeseen wave of voluntary compliance or significantly more follow-up by NOD would probably be required to acquire data to track/compare differences between historic and future management efforts and to comprehensively characterize responses to management |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SUBMERGED/ FLOATING AQUATIC VEGETATION**<br><br>Of interest to managers intent upon improving habitat for species targeted for management (primary) and/or forestalling marsh loss (secondary); evaluated by CORPS and some agencies during project comment period and review; some attributes subject to monitoring<br><br>Important Attributes<br><br>HYDROLOGY: Salinity<br>Affects species composition, growth rates, reproduction; potentially stressful, toxic<br><br>Temperature/ HYDROLOGY: Water depth<br>Increasing depths elevate potential for wave damage; extremely shallow depths increase potential temperature-induced biochemical stresses reducing growth or death from desiccation; some attributes subject to monitoring | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of invigorating/expanding this significant resource for erosion control and/or other purposes<br><br>*As a function of position*<br><br>See above<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in some cases, with the intent of enhancing/expanding this significant resource for erosion control and/or other purposes<br><br>**DELTA REGION**<br><br>*Historic*<br><br>*Future*<br><br>A significant commitment to management has been made in all but delta Basin 2; how many acres will ultimately be subjected to management that recognizes this resource as an indirect beneficiary of management, or is specifically intent upon affecting this significant resource to control erosion or for other purposes remains to be determined | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding this significant resource for erosion control and/or other purposes<br><br>*As a function of position*<br><br>See above<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of enhancing/expanding this significant resource for erosion control and/or other purposes<br><br>**CHENIER REGION**<br><br>*Historic*<br><br>see DELTA BASINS/REGIONS<br><br>*Future*<br><br>see DELTA BASINS/REGIONS | Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond to management for at least one growing season<br><br>However, complete or even partially documented reports characterizing how this significant resource actually responded to permitted management are too few in number to be considered representative<br><br>*Historic*<br><br>1) Considerably more projects targeted marshes exhibiting historic losses than have or will affect areas of higher potentials for future loss<br><br>2) Generally poor monitoring compliance-<br><br>a) has and will continue to hinder ability to detect/characterize normal variation and to react appropriately to real differences or explain range of responses to management efforts<br><br>b) prolong dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue merits of each management action<br><br>*Future*<br><br>1) The potential for addressing past losses and slowing, stopping or reversing future losses directly increases by management affecting this significant resource<br><br>2) Remains to be determined if differences between managed areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SUBMERGED/ FLOATING AQUATIC VEGETATION** (Continued)<br><br>Epiphytic Growth/ HYDROLOGY: Turbidity Prolonged reductions of light intensity can greatly suppress growth, reproduction<br><br>MARSH POND SOILS: Substrate (Consistency/ Composition) possible long-term influence on species composition<br><br>Production/Vigor | | | 3) Past and future research, report and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree, if any, inducing emergent vegetation to grow on exposable, eroded marsh soils contributes to forestalling marsh losses<br><br>4) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management approach that has promise but has yet to be proven generally effective in the long-term in stopping or reversing erosion<br><br>5) If successful, that commitment could encompass a substantial percentage of the aquatic emergent vegetation in coastal Louisiana by the year 2015, perhaps even a greater percentage than it would represent today<br><br>6) Research, an unforeseen wave of voluntary compliance or significantly more follow-up by NOD would probably be required to acquire data to track/compare differences between historic and future management efforts and to comprehensively characterize responses to management |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **MARSH POND SOILS**<br><br>Of interest to managers intent upon improving habitat for species targeted for management (often primary) and/or forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review; not subject to monitoring<br><br>**Important Attributes**<br><br><u>Surface Elevation</u><br><br><u>Water Depth</u><br><br><u>Persistence</u><br><br><u>Composition/ Consistency</u><br><br><u>Microorganisms/ Benthos</u> | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Basins 1, 2, 4, 5 and 7 - Provided adequate controls are achieved, this resource is expected to respond as intended to management; but, complete or even partially documented reports characterizing how this significant resource actually responded to permitted management are too few in number to be considered representative<br><br>*As a function of position*<br><br>See above<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Areas that would be brought under management include this significant resource; in some cases, with the intent of affecting this significant resource for erosion control and/or other purposes<br><br>**DELTA REGION**<br><br>***<u>Historic</u>***<br><br>Deliberate attempts were made to affect this significant resource for erosion control and/or other purposes<br><br>***<u>Future</u>***<br><br>A significant commitment to management has been made in all but delta Basin 2; how many acres will ultimately be subjected to management remains to be determined | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of affecting this significant resource for erosion control and/or other purposes<br><br>*As a function of position*<br><br>See DELTA BASINS<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of enhancing/expanding this significant resource for erosion control and/or other purposes<br><br>**CHENIER REGION**<br><br>***<u>Historic</u>***<br><br>see DELTA BASINS/REGIONS<br><br>***<u>Future</u>***<br><br>see DELTA BASINS/REGIONS | Provided adequate hydrologic controls can be achieved and sustained, this significant attribute can be expected to respond to management as intended for at least one growing season, with residual effects extending into a second growing season<br><br>***<u>Historic</u>***<br><br>1) A resource sometimes targeted for management as an integral but indirect contributor to controlling erosion or invigorating the habitat of other marsh dependent resources<br><br>2) Generally poor literature accounts and monitoring results make predicting impacts and effects largely a theoretical exercise rather than a prediction based upon how often and how extensive the intended response actually occurred in similar situations<br><br>***<u>Future</u>***<br><br>1) Management actions affecting this resource make an indirect contribution to the potential to improve conditions for targeted marsh species, and/or addressing past losses, or slowing, stopping or reversing future marsh losses<br><br>2) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management approach that my involve this resources as an integral but indirect contributor to controlling erosion or enhancing the habitat of other marsh dependent resource<br><br>3) Remains to be determined if differences between managed areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **FISH, SHRIMP AND CRABS**<br><br>Never a stand-alone reason for undertaking management, typically accommodated as long as management effort is not compromised; evaluated by CORPS and some agencies during project comment period and review; some attributes may be subject to monitoring<br><br>Important Attributes<br><br><u>Interspersion</u><br><br><u>Water Depth</u><br><br><u>Salinity</u><br><br><u>Water Velocity</u> | BASIN-BY-BASIN: Permitted Projects<br><br>Basins 1, 2, 4, 5 and 7 - Although monitoring results characterizing how these significant resources actually responded to permitted management efforts are virtually nonexistent; unavoidable, reciprocal/compensatory shifts in numbers, biomass and species assemblages almost certainly have been induced by management<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control, and/or other purposes<br><br>2) Most management efforts, regardless of their success, reduce access by estuarine dependent species to many managed marshes as well as some seasonal movements between marshes and marsh types; more successful management efforts apparently induce conditions that in the short-term favor fresher-water species assemblages; such differences may have local socioeconomic implications; management in Basin 4 (considering permitted management only) and in Basin 7 (considering also the acreage currently managed by other entities) has been pursued on a scale suggesting a potential for significant effects<br><br>*As a function of position*<br><br>Project landscape patters would suggest that inter-project influences on this significant resource have begun to occur in Basins 4 and 7; movements/access to and from adjacent managed marshes have been reduced/rerouted from several to as little as one waterway, or may require transitting more than one structure | BASIN-BY-BASIN: Permitted Projects<br><br>see DELTA BASINS AND REGION<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Most management efforts, regardless of their success, reduce access by estuarine dependent species to many managed marshes as well as some seasonal movements between marshes and marsh types; more successful management efforts apparently induce conditions that in the short-term favor fresher-water species assemblages; such differences may have local socioeconomic implications; management in Basin 9 (considering permitted management only) and in Basins 8 and 9 (considering also the acreage currently managed by other entities) has been pursued on a scale suggesting a potential for significant effects<br><br>*As a function of position*<br><br>Project landscape patterns suggest that inter-project influences on this significant resource have begun to occur in Basins 8 and 9; movements/access to and from adjacent managed marshes have been reduced/rerouted from several to as little as one waterway, or may require transitting more than one structure | 1) Generally poor monitoring compliance-<br><br>a) has and will continue to hinder ability to detect/characterize normal variation and to react appropriately to real differences or explain range of responses to management efforts<br><br>b) prolong dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue merits of each management action<br><br>2) Remains to be determined if differences between managed areas, as well as management options, are categorical, site-specific, or some combination of both<br><br>*<u>Historic</u>*<br><br>1) Routinely, efforts were made to reduce/minimize adverse impacts to the dependent migratory marine/estuarine component of this significant resource<br><br>2) Typically such efforts were undertaken only to the extent that they didn't undermine stipulated project purpose(s)<br><br>3) Unavoidable compensatory shifts in numbers, biomass and species assemblages were broadly accepted as inevitable, and presumed either insignificant or offset by desired changes in other significant resources<br><br>4) Having virtually no monitoring results from permitted management efforts reduces predicting quantitative impacts and effects to a theoretical exercise rather than a prediction reflective of actual responses |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **FISH, SHRIMP AND CRABS** (Continued)<br><br>Interspersion, Flooding Frequency/Water Depth, Salinity<br><br>*SEE ALSO*<br><br>**SUBMERGED/ FLOATING AQUATIC VEGETATION**<br><br>**EMERGENT VEGETATION ON UNERODED NATIVE SOILS**<br><br>**EMERGENT VEGETATION ON EXPOSABLE ERODED SOILS**<br><br>**WILDLIFE**<br><br>**HYDROLOGY Salinity**<br><br>**HYDROLOGY Water**<br><br>**SECONDARY PRODUCTION**<br><br>**SOCIO-ECONOMICS** | **BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control, and/or other purposes<br><br>2) The impacts of the projects would reinforce the consequences associated with the historic commitment to management in Basin 4; Basin 5 is expected to exhibit the same trends observed in Basins 4 and 7, and even more extensively, as a result of a significant commitment to management as a way to control erosion in Basin 5<br><br>**DELTA REGION**<br><br>*Historic*<br><br>In terms of acreage alone, a significant commitment to management has occurred in Basin 4 that has the potential to shift species assemblages to some degree that could be the basis for potential significant socioeconomic implications in Basin 4<br><br>*Future*<br><br>1) in terms of acreage alone, the commitment to management affecting the life requisite resources of these significant resources would be appreciably expanded in Basin 4<br><br>2) a significant commitment to management would arise in Basin 5 a- with the same biological and socioeconomic implications relative to these significant resources in that basin as addressed in Basin 4, but b) those effects have the potential to be more intensive because of the hydrologic interdependencies that would arise from the spatial orientation of candidate projects | **BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control, and/or other purposes<br><br>2) The impacts of the projects would reinforce/prolong the consequences associated with the historic commitment to management in Basin 8; the marshes comprising the western one quarter Basin 9 are expected to exhibit the same trends observed elsewhere in Basin 9 and Basin 8; the effects in Basin 9 are expected to intensify as a result of the significant commitment to management as a way to control erosion in Basin 9<br><br>**CHENIER REGION**<br><br>*Historic*<br><br>In terms of acreage alone, a significant commitment to management has occurred in Basin 9 that has the potential to shift species assemblages to some degree that could be the basis for potential significant socioeconomic implications in Basin 9<br><br>*Future* see DELTA BASINS | *Future*<br><br>1) Management actions will continue to affect this resource although the focus of management efforts will likely continue to be on addressing past current and future marsh losses and/or improving habitat conditions for other targeted marsh species<br><br>2) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to management options that unavoidably involve these resources<br><br>3) If successful, that commitment by 2015 could encompass an even larger percentage of the remaining habitats upon which the migratory estuarine dependent species depend for life requisite resources than it does today<br><br>4) As surrounding unmanaged marshes undergo natural succession/erosion, management efforts will likely have to intensify to perpetuate a particular species assemblage of this significant resource<br><br>5) Past and future research, reports and studies and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree these resources are unavoidably effected<br><br>6) Research is probably the most likely vehicle for comprehensively characterizing responses to management |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **WILDLIFE**<br><br>**Improving habitat/numbers of some species often a stand-alone reason for undertaking management; evaluated by CORPS and some agencies during project comment period and review; some attributes may be subject to monitoring**<br><br>**Important Attributes**<br><br>**Reptiles**<br><br>**Amphibians**<br><br>**Birds**<br><br>**Mammals**<br><br>**Furbearers**<br><br>*** Salinity**<br><br>*** Pond/Water Depth**<br><br>*** Pond:/marsh ratio; size; interspersion**<br><br>*** Pond plants**<br><br>*** Native emergent vegetation**<br><br>*** Induced emergent vegetation**<br><br>**Waterfowl**<br><br>*** Pond/water depth** | **BASIN-BY-BASIN: Permitted Projects**<br><br>***As a function of acreage***<br><br>**1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Significant/Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some of the important attributes of this significant, and/or for erosion control**<br><br>**2) Improved conditions have likely arisen for nearly all of the approximately 35 reptilian and amphibian species, most of the more than 100 birds species and two or three of the dozen or so mammalian species that acquire life requisite resources from the nearly 53,000 acres of fresh, intermediate or fresh/intermediate marsh brought under management**<br><br>**3) Except for waterfowl and furbearers (including alligators) those resources are untargeted beneficiaries of management**<br><br>***As a function of position***<br><br>**No apparent trends or implications** | **BASIN-BY-BASIN: Permitted Projects**<br><br>***As a function of acreage***<br><br>**1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more Significant/Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding some of the important attributes of this significant, and/or for erosion control**<br><br>**2) Improved conditions have likely arisen for nearly all of the approximately 35 reptilian and amphibian species, most of the more than 100 birds species and two or three of the dozen or so mammalian species that acquire life requisite resources from the nearly 33,000 acres of fresh, intermediate or fresh/intermediate marsh brought under management**<br><br>**2) Except for waterfowl and furbearers (including alligators) those resources are untargeted beneficiaries of management**<br><br>***As a function of position***<br><br>**No apparent trends or implications** | **1) The response of most important attributes to management is directly proportional to the degree of control that is achieved and sustained; several of the important attributes can be expected to respond to management for at least one growing season, but the potential response by waterfowl in any given season improves in proportion to the degree hydrologic controls can be achieved and sustained relative to aquatic vegetation**<br><br>**2) Although monitoring results characterizing how these significant resources actually responded to permitted management efforts are virtually nonexistent, unavoidable, compensatory shifts in numbers, biomass and species assemblages almost certainly could have been induced by management**<br><br>***Historic and Future***<br><br>**1) Generally poor monitoring compliance-**<br><br>**a) has and will continue to hinder ability to detect/characterize normal variation and to react appropriately to real differences or explain range of responses to management efforts**<br><br>**b) prolong dependency upon insights, opinions and inferences from literature to define problems, design solutions and argue merits of each management action**<br><br>**2) Having virtually no monitoring results from permitted management efforts reduces predicting quantitative impacts and effects to a theoretical exercise rather than a prediction reflective of actual responses**<br><br>**3) In all basins, a- the wildlife species that can be considered unintended beneficiaries of management for waterfowl and/or marsh restoration in the brackish or saline marsh types drops dramatically, and b- waterfowl, alligators and some furbearing species become the principal wildlife beneficiaries of managing brackish marsh** |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **WILDLIFE** (Continued)<br><br>• Pond:/marsh ratio; size; interspersion<br><br>• Pond/water plants<br><br>• Native emergent vegetation<br><br>• Induced emergent vegetation<br><br>Production<br><br>BASINS: Future CWPPRA Projects<br><br>REGION | **BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; in many cases, with the intent of invigorating/expanding some of the important attributes of this significant and/or for erosion control<br><br>2) Only Basin 5 is expected to exhibit any appreciable expansion of the trends noted for the permitted projects as a result of a significant commitment to management as a way to control erosion in Basin 5<br><br>**REGION**<br><br>***Historic***<br><br>1) On an acreage basis, waterfowl were a targeted significant attribute- a) about half the time, and, b) more often when brackish marsh was an included marsh type in all but Basin 5.<br><br>2) Waterfowl likely were the wildlife attribute that benefitted more so than any other from management of brackish and/or saline marsh types, where significantly fewer wildlife species (except for some migratory shore birds) can routinely acquire life requisites | **BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more Significant Resources/Important Attributes, thereby unavoidably affecting this significant resource; in many cases, with the intent of invigorating/expanding some of the important attributes of this significant and/or for erosion control<br><br>1) In Basin 9- a) nearly 41,000 acres of fresh and/or intermediate marsh (inclusive of shallow open water) would be brought under first-time management, benefitting wildlife and b) 100,000 acres, mostly fresh or intermediate marshes and shallow open water, would be encompassed by proposed efforts designed to reestablish, prolong or upgrade prior or ongoing management efforts, again<br><br>2) The commitment to management in Basin 9 could produce significantly improved overwintering conditions<br><br>**REGION**<br><br>***Historic***<br><br>1) On an acreage basis, waterfowl were a targeted significant attribute- a) only about a third of the time, but b) more often when brackish marsh was an included marsh type in Basin 8.<br><br>2) Waterfowl likely were the wildlife attribute that benefitted more so than any other from management of brackish and/or saline marsh types, where significantly fewer wildlife species (except for some migratory shore birds) can routinely acquire life requisites | 4) Permitted projects are presumed to encompass 88,000 acres of fresh or intermediate marsh; that number increases to 380,460 acres when projects that include only the fresh, intermediate and/or brackish marsh types<br><br>5) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management effort that has promise but has yet to be proven to repetitively yield significantly greater response for the more intensive management efforts<br><br>6) Regardless, that commitment could encompass a grater percentage of the life requisite resources for many wildlife species in coastal Louisiana by the year 2015 than managed areas represent today<br><br>7) The potential to convincingly argue that unavoidable adverse effects incurred by fish, shrimp and crabs from management can be partially or wholly offset by benefits to wildlife in general and reduced erosion rates would seem to be greatest when management involves the fresh and/or intermediate marsh types<br><br>8) Waterfowl, some furbearers and to a lesser degree alligators and wading and shorebirds would be principal beneficiaries in brackish marsh |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **WILDLIFE** (Continued) | 3) The commitment to management for wildlife has apparently occurred as a direct result of an interest in waterfowl, probably even more if the effort encompassed the brackish marsh type; that commitment has already been a source of disagreement and could be could be the basis for potential significant socioeconomic implications<br><br>*Future*<br><br>The historic trend is expected to continue | 3) The commitment to management for wildlife has apparently occurred as a direct result of an interest in waterfowl, probably even more if the effort encompassed the brackish marsh type; that commitment has already been a source of disagreement and could be could be the basis for potential significant socioeconomic implications<br><br>*Future*<br><br>The historic trend is expected to expand, with concurrent biologic and socioeconomic implications | 8) Management for wildlife, especially targeting waterfowl, is expected to be a continuing source of controversy with socioeconomic implications<br><br>9) Management efforts will likely have to intensify in targeted marshes to sustain managed conditions as the surrounding unmanaged marsh undergo natural succession |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SUBSURFACE GEOLOGY**<br><br>Typically of little or no direct interest to managers; evaluated by CORPS and some agencies during project comment period and review; not subject to monitoring<br><br>**Important Attributes**<br><br>Faults<br><br>Settlement Potential | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Never explicitly considered or monitored<br><br>*As a function of position*<br><br>Never explicitly considered or monitored<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Never explicitly considered and not proposed for monitoring; however, could influence expectations, choice of management alternative and design of candidate projects relative to efforts to address historic erosion or slow, stop or reverse on-going marsh losses related to changes in soil surface elevations | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Never explicitly considered or monitored<br><br>*As a function of position*<br><br>Never explicitly considered or monitored<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>Never explicitly considered and not proposed for monitoring; however, could influence expectations, choice of management alternative and design of candidate projects relative to efforts to address historic erosion or slow, stop or reverse on-going marsh losses related to changes in soil surface elevations | This significant resource is not expected to be affected by management<br><br>*Historic*<br><br>Not explicitly considered<br><br>*Future*<br><br>Could influence expectations, choice of management alternative and design of candidate projects relative to efforts to address historic erosion or slow, stop or reverse on-going marsh losses related to changes in soil surface elevations |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SURFACE GEOMOR-PHOLOGY**<br><br>Evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br><u>Dredged Material Embankments/ Water Control Structures</u> | BASIN-BY-BASIN: Permitted Projects<br><br>The rehabilitation of dredged material embankments that follow property/political boundaries (rather than biological boundaries) occurred as part of many permitted actions<br><br>The creation of new embankments also occurred<br><br>The permitting effort contributed to continuing the historic trend of partitioning the Delta marshes marsh into ever smaller, hydrologically semi-disconnected parcels<br><br>BASIN-BY-BASIN: CWPPRA Projects<br><br>The historic and permit trend is expected to continue, but with an a greater but not exclusive emphasis on lowering the elevation of embankments, an expanded use of slotted and rock weirs to foster more exchange, and to better account for natural hydrologies | See DELTA BASINS AND REGION | This significant resources is not expected to be subjected to management, but it is directly related to the potential to achieve hydrologic controls required to achieve other management goals and address socioeconomic interests<br><br>***<u>Historic and Future</u>***<br><br>The creation/maintenance rehabilitation of dredged material embankments that follow property/political boundaries (as opposed to biological boundaries) have occurred throughout coastal Louisiana marshes for many decades<br><br>The result has been to convert much of the coastal marshes into hydrologically semi-disconnected parcels<br><br>Many areas influenced by those features, especially when they created an impounded situation, have exhibited some of the greatest marsh losses, particularly in the Chenier marshes<br><br>The historic condition and a continuing commitment to management that relies upon linear surface features that follow political/property boundaries will continue that trend<br><br>Following property boundaries has significantly beneficial socioeconomic implications for landowners<br><br>Remains to be determined if differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Water**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>Important Attributes<br><br>Origin<br><br>Flooding Frequency<br><br>Flooding Duration<br><br>Water Depth<br><br>Velocity<br><br>**SURFACE GEOMOR-PHOLOGY**<br>Dredged Material Embankments/ Water Control Structures | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>The hydrology of 235,315 acres of Basin 4 is presumed to be affected, an acreage about seven times larger than the permitted acres presumed to be under management in any other of the delta basins<br><br>*As a function of position*<br><br>In Basin 4 there is probably a potential for interactions between permitted projects, as well as some of the unmanaged portion of the basin<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some other significant resources for erosion control, and/or other purpose<br><br>2) As has been the case in the past, projects that would bring areas under management would be designed and/or operated to greatly affect many of the Important Attributes of this significant resource<br><br>In Basin 5 that initiative could bring nearly 155,000 acres under management, an acreage nearly three times larger than the next largest effort (Basin 4, about 55,000 acres) | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>The hydrology of 92,480 acres of Basin 9 affected by permitted management is twice the acreage affect in Basin 8<br><br>*As a function of position*<br><br>In both basins, interactions between permitted projects has already occurred, although in Basin 9 it was an a designed effort an on a much larger scale than could have occurred in Basin 8.<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Because of proposed management actions in Basin 8, the influence this significant resources exerts on 7,300 acres would be intentionally modified, without little or no anticipated effects on the hydrology elsewhere in the basin. | The response of this significant resource to management is apparently directly proportional to the degree of control that can be achieved and sustained and directly determines the potential to achieve other management goals<br><br>However, adequately or even partially documented monitoring reports characterizing the actual effect of management on the hydrology within or on nearby managed areas are too few in number to be considered representative<br><br>***Historic and Future***<br><br>1) Generally poor literature accounts and a very limited number of reliable monitoring results make predicting impacts and effects largely a theoretical exercise rather than a prediction based upon how often and how extensive the intended response actually occurred in similar situations<br><br>2) Important Attributes of this Significant Resource probably have already been significantly modified in Basin 9<br><br>3) Complete implementation of the proposed future projects is expected to significantly change several of the Important Attributes of this component of hydrology throughout the region |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Water** (Continued) | **REGION**<br><br>***Historic***<br><br>The commitment to management pursued on the scale exhibited in Basin 4 suggests a potential for significance that could have biological and socioeconomic implications in that Basin<br><br>***Future***<br><br>The commitment to management that could arise in Basin 5 suggests a potential for significance that could have biological and socioeconomic implications in that basin | 3) Because of proposed management actions in Basin 9, the influence this significant resources exerts on 206,873 acres would be intentionally modified;<br>a commitment to management that effects this significant resource on that scale is significant unto itself independent of whether the effect is beneficial or adverse to any other significant resources<br><br>**REGION**<br><br>***Historic and Future***<br><br>1) Collectively, nearly the entire wetlands/open water complex of Basin 9 could be brought under management<br><br>2) The proposed projects would reinforce (Basin 8) and significantly expand (Basin 9) the already significant historic commitment to management<br><br>3) More of the marshes in this region would be influenced by the dictates of management than respond to the natural rhythms of the unmanaged estuary; a significant change in circumstances | |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Sediments**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>**Important Attributes**<br><br>Origin External and internal<br><br>Overtopping water levels<br><br>Composition Substitutability of organic and mineral sediments<br><br>Penetration/ Delivery What controls the rate/volume of sediments delivered to the managed area<br><br>Retention What controls the volume of delivered sediments retained | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) The hydrology of 235,315 acres of Basin 4 is presumed to be affected, an acreage about seven times larger than the permitted acres presumed to be under management in any other of the delta basins<br><br>*As a function of position*<br><br>In Basin 4 there is probably a potential for interactions between permitted projects, as well as some of the unmanaged portion of the basin<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some other significant resources for erosion control, and/or other purpose<br><br>2) As has been the case in the past, the design and operation of projects that would bring areas under management would unavoidably affect many of the Important Attributes of this significant resource | **BASIN-BY-BASIN: Permitted Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) The hydrology of 92,480 acres of Basin 9 affected by permitted management is twice the acreage affect in Basin 8<br><br>*As a function of position*<br><br>In both basins, interactions between permitted projects has already occurred, although in Basin 9 it was an a designed effort an on a much larger scale than could have occurred in Basin 8.<br><br>**BASIN-BY-BASIN: CWPPRA Projects**<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Because of proposed management actions in Basin 8, the influence this significant resources exerts on 7,300 acres would be intentionally modified, without little or no anticipated effects on the hydrology elsewhere in the basin.<br><br>3) Because of proposed management actions in Basin 9, the influence this significant resources exerts on 206,873 acres would be intentionally modified; a commitment to management that effects this significant resource on that scale is significant unto itself | The response of some important attributes to management is inversely proportional, some respond in direct proportion while one is only partly related to the degree of control that is achieved and sustained and directly determines the potential to achieve other management goals<br><br>However, adequately or even partially documented monitoring reports characterizing the actual effect of management on the sediment dynamics within or on nearby managed areas are too few in number to be considered representative<br><br>***Historic and Future***<br><br>1) Generally poor literature accounts and a very limited number of reliable monitoring results make predicting impacts and effects largely a theoretical exercise rather than a prediction based upon how often and how extensive the intended response actually occurred in similar situations<br><br>2) Important Attributes of this Significant Resource probably have already been significantly modified in Basin 9, especially east and immediately west of Calcasieu Lake<br><br>3) Complete implementation of the proposed future projects is expected to appreciably change several of the Important Attributes of this component of hydrology in Basin 9, significantly within targeted areas and with largely unknown effects throughout the basin |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Sediments** (Continued) | **REGION**<br><br>***Historic***<br><br>The commitment to management pursued on the scale exhibited in Basin 4 (if fully implemented) suggests a potential for significance that could have biological and/or socioeconomic implications regardless of the response to management<br><br>***Future***<br><br>The commitment to management that could arise in Basin 5 suggests a potential for significance that could have biological and socioeconomic implications in that basin regardless of the response to management | **REGION**<br><br>***Historic and Future***<br><br>1) Collectively, nearly the entire wetlands/open water complex of Basin 9 could be brought under management<br><br>2) Considering the portion of Basin 8 that is also already under management of some form,<br><br>3) more of the marshes in this region would be influenced by the dictates of management than respond to the natural rhythms of the unmanaged estuary; a significant change in circumstances | |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Salinity**<br><br>Of interest to managers as part of problem to be solved, increasing general interest due to role in forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review<br><br>**Important Attributes**<br><br>Concentration<br>* Average - Characterizes marsh types, used in formulating management protocols<br><br>* Maximum-Relative to marsh type can be stressful or lethal<br><br>Duration Relative to marsh type, prolonged exposure can be stressful or lethal<br><br>Depth Elevating soil water salinities can be stressful or lethal | BASIN-BY-BASIN: Permitted Projects<br><br>Basins 1, 2, 4, 5, and 7 - Inconclusive - adequately or even partially documented monitoring reports characterizing the actual effect of management on the salinity dynamics within or on nearby managed areas are too few in number to be considered representative<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) The hydrology of 235,315 acres of Basin 4 is presumed to be affected, an acreage about seven times larger than the permitted acres presumed to be under management in any other of the delta basins<br><br>*As a function of position*<br><br>In Basin 4 there is probably a potential for interactions between permitted projects, as well as some of the unmanaged portion of the basin<br><br>BASIN-BY-BASIN: CWPPRA Projects<br><br>1) Every one of the proposed projects (268,402 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some other significant resources for erosion control, and/or other purpose<br><br>2) As has been the case in the past, the design and operation of projects that would bring areas under management would unavoidably affect many of the Important Attributes of this significant resource | BASIN-BY-BASIN: Permitted Projects<br><br>Basins 8 and 9 - Inconclusive - adequately or even partially documented monitoring reports characterizing the actual effect of management on the salinity dyuamics within or on nearby managed areas are too few in number to be considered representative<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases with the intent of invigorating/expanding other significant resource for erosion control, and/or other purposes<br><br>2) The hydrology of 92,480 acres of Basin 9 affected by permitted management is twice the acreage affect in Basin 8<br><br>*As a function of position*<br><br>In both basins, interactions between permitted projects has already occurred, although in Basin 9 it was an a designed effort an on a much larger scale than could have occurred in Basin 8<br><br>BASIN-BY-BASIN: CWPPRA Projects<br><br>1) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Because of proposed management actions in Basin 8, the influence this significant resources exerts on 7,300 acres would be intentionally modified, without little or no anticipated effects on the hydrology elsewhere in the basin | The overall response of this significant resource to management is apparently directly proportional to the degree of control that can be achieved and sustained and directly determines the potential to achieve other management goals<br><br>*Historic and Future*<br><br>1) Generally poor literature accounts and a very limited number of reliable monitoring results make predicting impacts and effects largely a theoretical exercise rather than a prediction based upon how often and how extensive the intended response actually occurred in similar situations<br><br>2) Important Attributes of this Significant Resource probably have already been significantly modified in Basin 9<br><br>3) Complete implementation of the proposed future projects is expected to significantly change several of the Important Attributes, leading to a stabilization or possible reduction of this significant resource in many of the targeted marshes, with the potential to have nearly basin-wide affects in Basins 5 and 9.<br><br>4) Past and future research from Louisiana and elsewhere are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree important attributes are affected by management and the implications of any induced differences |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HYDROLOGY: Salinity** (Continued) | **REGION**<br><br>***Historic***<br><br>The commitment to management pursued on the scale exhibited in Basin 4 suggests a potential for significance that could have biological and socioeconomic implications in that Basin regardless of the response to management<br><br>***Future***<br><br>The commitment to management that could arise in Basin 5 suggests a potential for significance that could have biological and socioeconomic implications in that basin regardless of the response to management | 3) Because of proposed management actions in Basin 9, the influence this significant resources exerts on 206,873 acres would be intentionally modified; a commitment to management that effects this significant resource on that scale is significant unto itself<br><br>**REGION**<br><br>***Historic and Future***<br><br>1) Collectively, nearly the entire wetlands/open water complex of Basin 9 could be brought under management<br><br>2) The proposed projects would reinforce (Basin 8) and significantly expand (Basin 9) the already significant historic commitment to management<br><br>3) more of the marshes in this region would be influenced by the dictates of management than respond to the natural rhythms of the unmanaged estuary; a significant change in circumstances | |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **HAZARDOUS, TOXIC & RADIOACTIVE WASTES**<br><br>Evaluated by CORPS and some other Federal agencies during project comment period and review<br><br>Important Attributes<br><br>Examples-<br><br>Heavy Metals<br><br>Petroleum/Mineral Extraction Wastes/Discharges<br><br>Pesticide Residues | Procedures exist to identify/resolve issues related to hazardous, toxic and radioactive resources on a case-by-case basis | Procedures exist to identify/resolve issues related to hazardous, toxic and radioactive resources on a case-by-case basis | This significant resource is not expected to be knowingly subjected to management<br><br>Procedures exist to identify/resolve issues related to hazardous, toxic and radioactive resources on a case-by-case basis |

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# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **MARSH MICRO-ORGANISMS**<br><br>Never has been a reason to undertake management; involved in nutrient dynamics, break-down rates of organic matter (see also Emergent and Aquatic Vegetation significant resource headings); in the absence of oxygen, sulphur driven species/processes apparently become quite prominent in break-down processes; evaluated by CORPS during project comment period and review; not subject to monitoring<br><br>**Important Attributes**<br><br>Bacteria/ Fungi/Viruses<br><br>Dissolved Oxygen/ Turbidity<br><br>Temperature<br><br>Particle size<br><br>Flooding Duration/ Depth of Flooding<br><br>Salinity | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resources for erosion control and/or other purposes<br><br>2) Every one of the proposed projects (268,402 acres) would affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some other significant resources for erosion control, and/or other purpose<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***Historic and Future***<br><br>see COASTWIDE | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resources for erosion control, and/or other purposes<br><br>2) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resources for erosion control and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***Historic and Future***<br><br>see also COASTWIDE | The overall response of this significant resource should reflect the degree of short-term hydrologic control that has been achieved<br><br>Not monitored and apparently no definitive studies in managed Louisiana marshes- a) means the ability to detect/characterize normal variation and real differences or explain range of responses to management efforts is greatly hindered, and b) reduces predicting quantitative impacts and effects to a theoretical exercise rather than a prediction reflective of actual responses<br><br>***Historic***<br><br>1) Recent Louisiana studies suggest a possible role of this significant resource in marsh loss (related to sulphur regimes)<br><br>2) Generally, the response appears to be one of unavoidable, reciprocal, and compensatory shifts in numbers, biomass and probably species assemblages with corresponding implications to nutrient dynamics and soil chemistry conditions<br><br>***Future***<br><br>1) Remains to be determined to what degree differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both<br><br>2) Past and future research from Louisiana and elsewhere are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree important attributes are affected by management and the implications of any induced differences |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **PHYTO-PLANKTON**<br><br>Never has been a reason to undertake management; involved in organic matter processing, nutrient dynamics, contribute to primary production, and are themselves a major food source for zooplankton and plankton-eating organism; evaluated by CORPS during project comment period and review; not subject to monitoring<br><br>Important Attributes<br><br><u>Dissolved Oxygen/ Turbidity</u><br><br><u>Nutrients</u><br><br><u>Temperature</u><br><br><u>Flooding Duration/ Depth of Flooding</u><br><br><u>Zooplanktors/ Fish/ Benthos</u> | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Every one of the proposed projects (268,402 acres) has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding some other significant resources for erosion control, and/or other purpose<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***<u>Historic and Future</u>*** | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>2) Every one of the proposed projects (214,173 acres) has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding other significant resource for erosion control and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***<u>Historic and Future</u>*** | The overall response of this significant resource should reflect the degree of short-term hydrologic control that has been achieved<br><br>Not monitored and apparently no studies in managed Louisiana marshes means- a) the ability to detect/characterize normal variation and real differences or explain range of responses to management efforts is greatly hindered, and b) reduces predicting quantitative impacts and effects to a theoretical exercise rather than a prediction reflective of actual responses<br><br>***<u>Historic</u>***<br><br>Generally, the response appears to be one of unavoidable, reciprocal/compensatory shifts in numbers, biomass and species assemblages, with a general reduction in areas subjected to prolonged water level drawdowns with corresponding implications to nutrients, zooplankton and primary and secondary production<br><br>***<u>Future</u>***<br><br>1) Remains to be determined to what degree differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both<br><br>2) Past and future research from Louisiana and elsewhere are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to what degree important attributes are affected by management and the implications of any induced differences |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **NUTRIENTS**<br><br>Never has been a reason to undertake management; reciprocal interdependency between growth and dynamics of microorganisms and plants; evaluated by CORPS during project comment period and review; possible project-level and cumulative implications; not subject to monitoring<br><br>**Important Attributes**<br><br><u>Oxygen</u><br><br><u>Temperature</u><br><br><u>Sulphur</u> - soil concentration is index to duration of flooding, physiological state of plants, toxic in high concentrations<br><br><u>HYDROLOGY:</u><br><u>Salinity</u><br>Soil and surface water concentrations are index to physiological state of plants, potentially toxic even in relatively low surface water concentrations<br><br><u>Nitrogen, Phosphorous, Iron Potassium & Silicon</u><br>Essential for growth | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases with the intent of invigorating/expanding other significant resources to control erosion, and/or other purposes<br><br>2) Every one of the proposed projects (268,402 acres) was designed to affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases with the intent of invigorating/expanding other significant resources to control erosion, and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***<u>Historic and Future</u>***<br><br>see also COASTWIDE | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases with the intent of invigorating/expanding other significant resources to control erosion, and/or other purposes<br><br>2) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding the emergent and aquatic vegetation components for erosion control, and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response can vary according to soil types, water chemistry, sediment budget, temperature, and water management regime<br><br>**REGION**<br><br>***<u>Historic and Future</u>***<br><br>see also COASTWIDE | 1) The overall response of several of the important attributes of this significant resource should reflect the degree of short-term hydrologic isolation that has been achieved<br><br>2) Predicting long-term responses by managed Louisiana marshes is largely a theoretical exercise, rather than a prediction based upon how often and how extensive the particular responses actually occurred in similar situations<br><br>3) Predicting some shorter-term general responses by managed Louisiana marshes can be inferred, with caution, from some limited on field data<br><br>***<u>Historic</u>***<br><br>Within managed areas, probably more so in areas subjected to repetitive water level reductions, microbial and phytoplankton species assemblages probably responded fairly rapidly and in a generally predictable way to physico-chemical differences induced by management which led, in turn, to corresponding biologically mediated shifts in the pathways, rates and amounts and forms nutrients occurred, with implications to plant growth and vigor<br><br>***<u>Future</u>***<br><br>1) Remains to be determined to what degree differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both<br><br>2) Past and future research from Louisiana and elsewhere are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine to at what scale and to what degree nutrient dynamic are affected by management and the implications of any induced differences, especially as nutrients budgets are linked with sediment budgets |

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## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **PRIMARY PRODUCTION**<br><br>Never the stipulated reason to manage, usually focuses on the emergent and aquatic vegetation components reactive to an interest forestalling marsh loss; evaluated by CORPS and some agencies during project comment period and review; some components subject to monitoring; project specific and cumulative implications<br><br>Important Attributes<br><br><u>Emergent Vegetation</u><br><br><u>Aquatic Vegetation</u><br><br><u>Benthic algae</u><br><br>**PHYTO-PLANKTON** | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding components of this significant resource, and/or other purposes<br><br>2) Every one of the proposed projects (268,402 acres) would affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding components of this significant resource, and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response very localized, apparently linked to specific water management regime and water chemistry, but also to sediment and nutrient dynamics, temperature and may be linked to soil type<br><br>**REGION**<br><br>***<u>Historic and Future</u>***<br><br>see COASTWIDE | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding components of this significant resource, and/or other purposes<br><br>2) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of invigorating/expanding components of this significant resource, and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response very localized, apparently linked to specific water management regime and water chemistry, but also to sediment and nutrient dynamics, temperature and may be linked to soil type<br><br>**REGION**<br><br>***<u>Historic and Future</u>***<br><br>see COASTWIDE | The overall response directly reflects the degree of hydrologic control that has been achieved and sustained in a growing season; the responses of some important attributes are used as an indices of management success<br><br>***<u>Historic and Future</u>***<br><br>1) Despite efforts to monitor and study how the emergent and aquatic vegetation components actually responded to management, a) the ability to predict how these components will respond to management is neither accurate nor precise, b) the ability to detect/characterize normal variation and real differences or explain ranges of responses to management efforts has yet to be refined, c) which reduces predicting quantitative impacts and effects to a largely a theoretical exercise rather than a prediction reflective of actual responses of these targeted components to management<br><br>2) However, in the short-term, and probably in the long-term as well, reciprocal/compensatory shifts in relative contributions by the important attributes is the most likely response to management<br><br>3) Remains to be determined if differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SECONDARY PRODUCTION**<br><br>Of continuing interest to managers, especially relative to targeted animal species; evaluated by CORPS and some agencies during project comment period and review<br><br>**Important Attributes**<br><br><u>Zooplankton</u><br><br><u>Benthos</u><br><br>See Also **WILDLIFE**<br><br><u>**THREATENED AND ENDANGERED SPECIES**</u><br><br>**FISH, CRABS and SHRIMP** | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented was designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in many cases, with the intent of affecting components of this significant resources and/or other purposes<br><br>2) Every one of the proposed projects (268,402 acres) would affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in most cases, with the intent of affecting components of this significant resources and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response very localized, apparently linked to specific water management regime and water chemistry, but also to sediment and nutrient dynamics, temperature and may be linked to soil type<br><br>**REGION**<br><br><u>*Historic and Future*</u><br><br>see COASTWIDE | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented has affected one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in many cases, with the intent of affecting components of this significant resources and/or other purposes<br><br>2) Every one of the proposed projects (214,173 acres) would be designed to affect one or more of the Important Attributes, thereby unavoidably affecting this significant resource; in many cases, with the intent of affecting components of this significant resources and/or other purposes<br><br>*As a function of position*<br><br>Form and degree of response very localized, apparently linked to specific water management regime and water chemistry, but also to sediment and nutrient dynamics, temperature and may be linked to soil type<br><br>**REGION**<br><br><u>*Historic and Future*</u><br><br>see COASTWIDE | The overall response indirectly reflects the degree of hydrologic control that has been achieved and sustained in a growing season; the responses of some important attributes are used as an indices of management success<br><br><u>*Historic and Future*</u><br><br>1) Little effort has been expended to confirm the magnitude of the presumed positive response of waterfowl, furbearer and alligator or aquatic species to permitted management efforts<br><br>2) The response/condition of selected life requisite resources for each component has been assumed to be representative<br><br>3) Other important components have largely been lightly regarded<br><br>4) The ability to predict how all these components will respond individually and in concert to management can be characterized in general terms as generally favorable for important attributes, but quantitatively is neither accurate nor precise, b) the ability to detect/characterize normal variation and real differences or explain ranges of responses to management efforts has yet to be refined, c) which reduces predicting quantitative impacts and effects to a largely theoretical exercise rather than a prediction reflective of actual responses of these targeted components to management<br><br>5) However, in the short-term, and probably in the long-term as well, reciprocal/compensatory shifts in relative contributions by the important attributes is the most likely response to management |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SECONDARY PRODUCTION** (Continued) | | | 6) Past and future research, report and studies, regulatory follow-ups and mandatory CWPPRA project-specific monitoring are the principal sources of insight managers and state and Federal permit decision makers will have available in the near term to determine in what way and to what degree, if any, individual important attributes respond to large-scale management efforts<br><br>7) Remains to be determined if differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both<br><br>8) Collectively, historic and future management initiatives represent a significant commitment of marsh acreage to a management approach that probably does have the intended management effects on the targeted components but the comprehensive response across all components has yet to be comprehensively documented for all important attributes<br><br>9) Assuming management can induce the intended effects on the targeted components, that commitment could encompass a substantial percentage of the secondary production associated with the remaining emergent vegetation by the year 2015 than it would today in coastal Louisiana |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SECONDARY PRODUCTION** (Continued) | | | 10) Management efforts will likely have to intensify in targeted marshes to sustain managed conditions as the surrounding unmanaged marsh undergo natural succession, with corresponding socio-economic implications |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **THREATENED AND ENDANGERED SPECIES/ MARINE MAMMALS**<br><br>Never a stand-alone reason for undertaking management; evaluated by CORPS and FWS/NMFS during project comment period and review<br><br>Important Attributes<br><br>Gulf sturgeon T<br>Pallid sturgeon E<br>Atlantic Ridley turtle E<br>Green turtle T<br>Leatherback turtle E<br>Loggerhead turtle T<br>Hawksbill turtle E<br>Alligator T<br>Brown pelican E<br>Southern bald eagle T<br>Arctic peregrine falcon T<br>Piping plover T<br>Humpback whale E<br>Finback whale E<br>Right whale E<br>Sei whale E<br>Sperm whale E<br>Louisiana black bear T<br>Florida panther E<br>Red wolf E | The Important Attributes are the Federally-listed Endangered and Threatened Species and Marine Mammals suspected to or have been confirmed to occur in Louisiana<br><br>Procedures exist to identify/resolve issues related to Threatened and Endangered Species and Marine Mammals; evaluation of projects by CORPS includes preliminary determination in public notice, and, as required, subsequent informal and/or formal consultation with the FWS and/or NMFS Any impacts associated with each and every previously permitted project were avoided/reduced/eliminated to the satisfaction of the FWS or NMFS prior to permit issuance. No permit authorizing activities was issued over a jeopardy opinion or when deemed detrimental to a listed species<br><br>The same procedures that have been successfully used to avoid/reduce/eliminated adverse effects to cultural resources for previously permitted projects is expected to function equally well as each project comes on line | see DELTA BASINS AND REGION | The important attributes that comprise this significant resource are not expected to be knowingly subjected to adverse management actions<br><br>see DELTA BASINS AND REGION<br><br>NOTE: The alligator and falcon are classified as threatened due to their similarity of appearance with other species<br><br>Also, please see the main text at 4.9.19.3. Marine Mammals and Threatened And Endangered Species, Table 4.1, and Appendix M |

# TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **SOCIO-ECONOMICS**<br><br>Some attributes of continuing interest to managers, landowners, and lease holders; many attributes of increasing general public interest; evaluation by CORPS also encompasses the overall public interest perspective, inclusive of any expressed concerns from managers, any other agencies, and members of the general public<br><br>Important Attributes<br><br>Fish and Wildlife Resources<br>Commercial<br>Recreational<br><br>Flood Control<br><br>Land Use/Land Loss<br><br>Mineral/Petroleum Extraction<br><br>Farms<br><br>Other Business Interests<br><br>Property Value<br><br>Public Facilities and Services<br><br>Employment and Labor Force | **BASIN-BY-BASIN: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (353,760 acres) presumed implemented either intentionally or more than likely unavoidably affected at least one of the Important Attributes<br><br>2) Every one of the proposed projects (268,402 acres) would either intentionally or more likely unavoidably affect at least one of the Important Attributes<br><br>*As a function of position*<br><br>Form and degree of response can be very localized, a function of the- a) structure type used to affect hydrologic controls, b) number of structures used, c) structure location, and, d) the user groups affect by the management actions<br><br>*Historic and Future*<br><br>In Basin 4 management has already been pursued on a geographic scale suggesting potential significant socioeconomic affects to several important attributes<br><br>A significant commitment to management in the future has been made in Basin 5 on a geographic scale suggesting potentially significant socioeconomic affects to several important attributes<br><br>see also COASTWIDE | **BASIN-BY-BASIN and REGION: Permitted and CWPPRA Projects**<br><br>*As a function of acreage*<br><br>1) Every permitted project (138,511 acres) presumed implemented either intentionally but more often unavoidably affected at least one of the Important Attributes<br><br>2) Every one of the proposed projects (214,173 acres) would either intentionally but more often unavoidably affect at least one of the Important Attributes<br><br>*As a function of position*<br><br>Form and degree of response can be very localized, a function of the- a) structure type used to affect hydrologic controls, b) number of structures used, c) structure location, and, d) the user groups affect by the management actions<br><br>*Historic and Future*<br><br>In Basin 9 management has already been pursued on a geographic scale suggesting potential significant socioeconomic affects to several important attributes<br><br>see also COASTWIDE | 1) The response of a few important attributes that comprise this significant resource are the ultimate indicators of how different components of society define what is acceptable and unacceptable about managing Louisiana's coastal marshes<br><br>2) The socioeconomic responses to management occur at all scales and without regard to time, and often independent of the biological response to management efforts; concerns about the economic effects of management have already been expressed over the years about several projects in several basins<br><br>3) Despite efforts to characterize how socio-economic attributes might actually responded to management, a) predicting how these components will respond to management is neither accurate nor precise, b) detecting/characterizing normal variation and real differences or explain ranges of responses to management efforts has yet to be refined, c) which reduces predicting quantitative impacts and effects to a largely theoretical exercise rather than a prediction reflective of actual responses of these targeted components to management<br><br>4) Remains to be determined if differences between managed and unmanaged areas, as well as management options, are categorical, site-specific, or some combination of both |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
| --- | --- | --- | --- |
| **SOCIO-ECONOMICS** (Continued)<br><br>Income<br><br>Displacement of People<br><br>Public Access<br><br>Tax Revenues<br><br>Community/Regional Growth<br><br>Health and Safety<br><br>Community Cohesion<br><br>Aesthetics<br><br>Noise<br><br>Environmental Justice | | | 6) Management efforts will likely have to intensify in targeted marshes to sustain managed conditions as the surrounding unmanaged marsh undergo natural succession, likely leading to intensification of socio-economic interactions |

## TABLE 5-20: CUMULATIVE EFFECTS - BY BASINS, REGIONS AND COASTWIDE (Continued)

| SIGNIFICANT RESOURCES | DELTA BASINS AND REGION | CHENIER BASINS AND REGION | COASTWIDE |
|---|---|---|---|
| **CULTURAL**<br><br>Of little interest to managers or general interest; evaluated by CORPS during project comment period and review<br><br>Important Attributes<br><br>Prehistoric<br><br>Historic | Procedures exist to identify/resolve issues related to Cultural Resources; evaluation of projects by CORPS includes preliminary determination in the public notice, a copy of which is sent to the State Historic Preservation Officer (SHPO) for comment, and, as required, consultation with the SHPO<br><br>Any impacts associated with each and every previously permitted project were avoided/reduced/eliminated to the satisfaction of the SHPO prior to permit issuance<br><br>The cultural resources that would be affected by proposed projects have been identified and can be the impacts assessed as each project comes on line<br><br>The same procedure that has been successfully used to avoid/reduce/eliminated adverse effects to cultural resources for previously permitted projects is expected to function equally well form future proposed projects | see DELTA BASINS AND REGION | The important attributes that comprise this significant resource are not expected to be knowingly subjected to adverse management actions<br><br>see DELTA BASINS AND REGION |

## 5.3. **Synthesis**

Louisiana's coastal marsh/open water complex encompasses about 4,500,000 acres. Previously issued permits for marsh management (1977-1995) encompass 492,271 acres (about 10 % of that complex). The typical project size is 6,000 to 7,000 acres (more than six square miles).

Candidate CWPPRA marsh management and hydrologic restoration projects could add 484,575 acres. Thus, nearly 1,000,000 acres could be under management in the foreseeable future. The Barataria (Basin 4), Terrebonne (Basin 5) and Calcasieu-Sabine Basins (Basin 9) collectively encompass 786,812 of those acres. Those numbers are stunning.

Practitioners of marsh management (or hydrologic restoration) cannot control the climate, geologic processes or the complicated socioeconomics associated with Louisiana's coastal marshes. Practitioners can merely react to and contend with the vicissitudes of climate, the certainty of geologic changes and the ever changing interplay of socioeconomic factors. Perhaps that is why marsh management has evolved over nearly half a century.

Despite nearly 50 years of practice and about 20 years of ever more intensive observation and study, the long-term and system-wide biological and ecological effects of marsh management in Louisiana remain to be conclusively documented. Most of the information from Louisiana focuses on the response of higher order animals to management that targets them or their specific life requisite resources. More recent Louisiana studies have focused on how biologically-mediated marsh processes are affected by management. The number of process-oriented or system-wide studies comparing managed and unmanaged Louisiana coastal marshes are few in number but growing. This trend is expected to continue.

Nonetheless, the picture that is emerging appears to be similar to what has been observed, studied and reported from several other areas. The results of a systems-oriented study of South Carolina marshes (subjected to a waterfowl management program very similar to waterfowl-oriented marsh management as practiced in Louisiana) are insightful. Productivity of managed and unmanged marshes can be quantitatively quite similar. However, the structure of the biological communities resident within unmanaged and managed marshes (and the biological processes that they mediate) can be significantly different. How well the South Carolina management results model mimics Louisiana's managed coastal marshes remains to be demonstrated.

The biological significance of those differences, however, is apparently in the eye of the beholder. A manager, whose job is assured for several more years after achieving the waterfowl/furbearer goals over the two preceding years, might reasonably conclude that the effort and all similar efforts coastwide were significantly successful. The freshwater fisheries biologist may come to a similar conclusion whereas the marine fisheries biologist might conclude just the opposite. Recreational and commercial fishermen may perceive management efforts as failures if they can't get into the managed areas to fish believing or knowing that there are bigger fish to be caught there.

At this point in time a marsh systems ecologist probably would be compelled to qualify any opinion on the matter, reflecting a genuine uncertainty. Although the evidence is clearly inconclusive, marsh management appears to have a greater potential to site-specifically slow erosion on some of the more stable soils of the Chenier plain. Convincingly demonstrating the assertion that marsh management can site-specifically stop or reverse marsh loss (even after nearly 10 years of undertaking projects with that outcome as a stipulated goal) also would seem to have a higher chance of occurring on some Chenier soils. The record demonstrating that the advantages of hydrologic restoration in this regard are not just theoretical remains to be written. However, hydrologic restoration projects that effectively reestablish former or upgrade existing marsh management projects would be expected to induce a different set of biological responses than would a hydrologic restoration project that truly emulates a former, natural hydrologic situation.

Regardless, any management effort, whether it succeeds or fails, involves trade-offs. The biological or ecological benefits or damages proponents as well as opponents of marsh management or hydrologic restoration can call upon to support their respective positions have typically proven to be real or probable and almost invariably have socioeconomic overtones.

The socioeconomic overtones would appear to be the result of the existing and increasing friction between competing user groups and not always compatible needs and interests of landowners/leaseholders and some members of the general public. So far, even site-specifically successful marsh management efforts have not eliminated the friction. Successfully slowing, stopping or reversing marsh losses with marsh management or hydrologic restoration may not reduce, eliminate or foster an amicable resolution of all socioeconomic conflicts. Thus, some of the socioeconomic issues related to marsh management and hydrologic restoration appear to be irresolvable. For these reasons,

we cannot rule out the probability that marsh management and hydrologic restoration have had, are having and probably will continue to have socioeconomic effects that are significant, at least to some segments of the population. Too little socioeconomic information specific to the issue of managing Louisiana's coastal marshes exists to make more definitive or convincing arguments one way or another.

One additional cumulative implication should be mentioned. The sources and types of controversy surrounding the management of Louisiana's coastal marshes, and the fate of the marsh-dependent organism that are affected by management, suggests the possibility that we are in a process of redefining the roles of public and private entities in the stewardship of public trust resources relative to the rights and privileges of landowners and leaseholders. Landowners/leaseholders are clearly entitled to protect their private property and control trespass. Through the CORPS permit program and the public funds to implement CWPPRA projects on private properties, landowners/leaseholders are aggressively asserting and rapidly acquiring a role as stewardship partners with public resources managers. The question is to what extent, if at all, does a landowner's/leaseholder's concern for protecting property rights extend to public trust resources that they help steward.

## 5.4. **Conclusions**

The biological and socioeconomic effects of marsh management and hydrologic restoration are not categorically definable by any particular project location, management alternative, project purpose, structure type(s) or operational plan(s) or even any combination. At this time, formulation of a single, defining statement applicable to all possible situations would probably itself be an imprecise representation of the matter.

Preparation this PHMEIS, and the literature review conducted in support of that effort, revealed that there is no simple or definitive answer to questions as broad as: "Do marsh management and hydrologic restoration projects work?"; and "What are the impacts associated with these projects?" Consideration of the facts suggests that in some instances, in certain areas and/or for certain purposes, marsh management can be, and hydrologic restoration has the potential to be, highly effective and may result in minimal adverse impact, whereas in other circumstances management efforts may be ineffective at best and can be extremely detrimental to one or more significant resources either locally or on a much broader scale.

Existing observation, studies, experiences and opinions are not definitive. As a result, many plausible interpretations can and often are offered in support of or to refute claims and assertions made by the scientific community, managers, landowners, leaseholders, members of the general public and agency personnel. Thus, the controversy and potential for socioeconomic significance surrounding hydrologic manipulations is largely due to differences of opinion as to what can and can't be site-specifically accomplished, the site-specific trade-offs involved, and the alleged or perceived biological and socioeconomic implications of these trade-offs.

But the NOD will continue to receive applications for permits to install structures to facilitate the management of marshes. The NOD will continue to evaluate those applications. And, the NOD will continue to make decisions to issue or deny the requested permits. Given the findings of this PHMEIS, the NOD finds no reason to depart from its current approach of evaluating each proposal on its own merits. Prior findings from both the scientific and lay communities are a valuable source of information which can be very useful in the decision-making process; however, this information must be used in the proper context, and care must be taken to avoid extrapolating too broadly and overgeneralizing, both of which can lead to erroneous conclusions for a given circumstance.

A comprehensive characterization of the socioeconomic implications of hydrologic manipulations, greater compliance with monitoring provisions by permittees, better designed monitoring programs as well as some additional rigorous scientific studies of selected biological attributes would improve the decision-making processes.

Table 5-1: CWPPRA- Pontchartrain Basin (Basin 1)

| PONTCHARTRAIN BASIN PROJECT NAME & NUMBER | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSOR | CWPPRA ACRES MM | CWPPRA ACRES HR | TYPE H2O MGT | CUMMULATIVE Additonal Acres MM | CUMMULATIVE Additonal Acres HR | COMMENT | INCLUI PERMI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IN CWPPRA BASIN PLAN | | | | | | | | | | | | | | |
| Fritchie Wetland PO-6 | | F/I | 2nd Priority List | Introduce fresh water and sediments from historic source | Install shunts; construct a sill at the outfall to prolong residence time | Slow internal marsh losses; invigorate existing marsh; more SAV | NRCS | | 5924 | Pass | | 5924 | Effort to emulate seasonal inputs/surface flow patterns relative to historic sources; new work | |
| Cutoff Bayou PO-11 | | B | Candidate for priority listing | Reduce erosive tidal scour, salinity | Rehab existing structures | Slow internal marsh losses; invigorate existing marsh; more SAV | None | | 3915 | Pass | | 3915 | | |
| Alligator Pt. PO-15 | | B | Permitted 1993, candidate for priority listing | Reduce erosive tidal scour, salinity | Install new water control structures at the perimeter | Slow internal marsh losses; invigorate existing marsh; more SAV | None | | 15578 | Act | 0 | | Area is included in boundaries of (IWW-N.O. to Mobile)65 active marsh mgt plan | (IWW-N. Mobile) for marsh manag |
| Manchac WMA XPO-51 | | I | Candidate for priority listing | Reduce soil salinity/seasonal salinity spikes | Install new water control structures at the perimeter | Slow general marsh losses; more SAV | None | 8000 | | Act | 8000 | | Public property; initial effort to intensively manage surface hydrology | |
| St. Malo XPO-84 | | B | Candidate for priority listing | Reduce erosive tidal scour, salinity | Install new?water control structures at the perimeter | Slow internal marsh losses; invigorate existing marsh; more SAV | None | | 2089 | Pass | | 1289 | Very stable marsh | |
| | | | | | | | Sub-totals | 8000 | 27506 | | 8000 | 11128 | | |

Table 5-1: Continued

IN CWPPRA BASIN 1 PLAN BUT NOT INCLUDED IN PMMEIS

Totals

| | | | |
|---|---|---|---|
| Violet Outfall Mgt PO-9a | B | Candidate for priority listing; component of State Plan | Does not emulate inputs from historic sources; structures intended to increase beneficial effects of outfall |
| SE Lake Maurepaus PO-5 | Marsh/ Swmp | State Plan Project; inactive | Deferred by CWPPRA |
| LaBranche West Mgt PO-12 | Marsh | Needs more study | Deferred by CWPPRA |
| Green/GoosePts. MR PO-14 | F/I/B | StatePlan Proj | Shore line stabilization coupled with sediment fencing |
| Eden Isle East PPO-4 | Pasture | 4th Priority List | Leveed, nonwet pasture |
| Hwy 51/RR Culverts PPO-19 | F/Swp | Needs more study | Essentially culvert maintenance; does not emulate historic situation |
| Port Louis HR PPO-20 | Closed ponds | | Landowner objects to project |
| Tangipohoa Swamp HR XPO-49 | Swamp | | Not a marsh type; deferred by CWPPRA |
| Bayou Savage NUWR-XPO-52a | F | 1st Priority List | Management of existing impoundment |
| Bayou Savage NUWR-Hwy 90-I-10 XPO-52b | F | 3rd Priority List | Management of existing impoundment |
| Seabrook Sill XPO-56 | | | Targets Lake Pontchartrain |
| Bayou Savage NUWR-XPO-64 | F/I | | No problems |
| MRGO Disposal Area XPO-71 | F | 3rd Priority List | Management of created/perched marsh |
| St. Bernard Marsh XPO-75 | B | | No planned project |
| Pontchatoula Marsh XPO-76 | F | | No problems |
| GIWW-Northern marshes XPO-77 | B | | |
| Bedico Marsh XPO-78 | F/I | | No problems |
| Jones Island Marsh XPO-79 | F/I | | No problems |

Table 5-2:CWPPRA- Breton Basin (Basin 2)

| BRETON BASIN<br>PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSOR | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additional Acres MM | CUMMULATIVE Additional Acres HR | COMMENT | INCLUI PERMI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| None | | | | | | | | | | | | | | |
| IN CWPPRA BASIN 2 PLAN BUT NOT INCLUDED IN PMMEIS | | | | | | | | | | | | | | |
| Interior Barrier PBS-8 | | | Future Candidate | Reduce external stressors | Create barrier | Reduce marsh loss | None | | • | | | | | |
| Restore Interior Ridge PBS-9 | | | Future Candidate | Reduce external stressors | Plug man-made gaps | Reduce marsh loss | None | | • | | | | | |
| Olga Foreshore Dike PBS-14 | | | Future Candidate | Improve overbank flows, better use fresh water and sediments | Modify inplace structure | Invigorate existing marsh | None | | • | | | | | |

Table 5-3: CWPPRA- Barataria Basin (Basin 4)

| BARATARIA BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSO | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additional Acres MM | CUMMULATIVE Additional Acres HR | COMMENT | INCLUDED PERMITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bayou Grand Chenier XBA-54 | | B | Conceptual; needs more study; candidate for priority listing | Tighten hydrologic boundaries; better use pump-supplied fresh water | Create/upgrade perimeter barriers; redirect flows, manage pump inputs | Protect/invigorate existing marsh; more SAV | None | | 38887 | Act | | 38887 | Effort to emulate seasonal inputs/surface flow patterns relative to historic sources; some structures used to contain/retain fresh water routed to marsh; maintaining boat access will be considered | |
| GIWW to Clovelly BA-2 | | F/I/B | 1st Priority List; Permitted: | Better use fresh water/ sediments and nutrients; reduce tidal scour | Construct new perimeter structuresto reduce tidal scour; increase fresh water retention times; manage pump inputs | Slow marsh loss rate, invirorate existing marsh, more SAV | NRCS | | 60000 | Act | | 0 | Effort to emulate inputs/surface flow patterns relative to historic sources; includes areas seperately permitted as (Lafourche Par w/i)733 & (Bayou Des Allemandes)107 | (Lafourche P w/i)733; (Bayou des Allemands)107 |
| Hwy 90 to GIWW * BA-6 | | F/I | Candidate for priority listing | Lower water levels, salinities; better use supplied fresh water, sediments & nutrients | Construct perimeter barriers to reduce tidal scour, increase fresh water retention times; manage pump inputs | Slow marsh loss rate, invigorate existing marsh, more SAV | NRCS | | 40000 | Act | | 0 | Effort to emulate inputs/surface flow patterns relative to historic sources; includes area seperately permitted as (Lafourche Par w/i)540 | (Lafourche P w/i)540 |
| Little Lake BA-14 | | B | Candidate for priority project listing | Rehab a portion of perimeter barriers between Little Lake and Lake Salvador | Rehab eroded levees/install water control structures to reacquire & upgrade former management capability | Slow marsh loss rates, invigorate existing marsh, more SAV | None | 2998 | | Act | 2548 | | Perpetuates/upgrades existing management capability; includes area seperately permitted as (Jefferson Par w/i)192 | (Jefferson P w/i)192 |
| Leeville Marshes PBA-32 | | B/S | Candidate for priority listing | Protect fringing/internal marshes | Armor shoreline; install new perimeter water control strucutres | Slow general marsh losses | None | | * | Pass | | | Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; location, design and number of structures is undetermined | |
| Bayou L'Ours Ridge PBA-34 | | B | Candidate for priority listing; design largely incomplete | Better use supplied fresh water, sediments & nutrients, reduce tidal scour | Construct new perimeter strucutres to reduce tidal scour, increase fresh water retention times; manage pump inputs | Slow marsh loss rates, invigorate existing marsh, more SAV | None | | 15600 | Act | | 3300 | Effort to emulate inputs/surface flow patterns relative to historic sources; maintaining boat access will be considered; (Lafourche P w/i)517 is active, others partially implemented and expired | (Lafourche P w/i)517; (Lafourche P w/i)547; (Lafourche P w/i)529; part of (Lafourche P w/i)577 |
| Jonathan Davis Wetland PBA-35 | | F | 2nd Priority List Permitted: | Reduce erosive tidal exchanges, salt water intrusion | Construct new perimeter barriers; rehab existing levees | Slow interior marsh loss rates; invigorate existing marsh, more SAV | NRCS | | 6450 | Pass | | 6450 | Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; effort to emulate surface flow patterns relative to historic sources; boat access will be maintained | |
| SE Lake Salvador PBA-61 | | F/I | Candidate for priority listing | Reduce shoreline erosion; reduce tidal scour along internal waterways | Install new shoreline erosion control features/perimeter barriers | Slow shoreline & internal marsh loss rates | None | | 3994 | Pass | | 3994 | Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; effort to emulate historic surface flows; boat access will likely decline | |
| | | | | | | | Sub-total | 2998 | 149331 | 0 | 2548 | 52631 | | |

Table 5-3: Continued

IN CWPPRA BASIN 4 PLAN BUT NOT INCLUDED IN PMMEIS

| | | | | |
|---|---|---|---|---|
| Central Basin Protected Zone XBA-63 | Conceptual, needs extensive study | Establish/defend zone | Create barriers to reduce tidal influences | Reduce marsh loss/sediment export |
| Hwy 90 Drainage Improvements PBA-42 | Conceptual only | Installation of larger culverts | | |
| Grand Bayou PBA-45 | Conceptual only | Similar to and possibly greater control of area described in XBA-54 | | |
| Marshes South of Clovelly XBA-49 | Candidate for priority listing | Focuses on shoreline protection, freshwater diversion | | |
| Little Lake Oil & Gas Field Canal Closures PBA-58 | Candidate for priority listing | Reduce erosive tidal exchanges, salt water intrusion | Construct new perimeter structures | Slow interior/shoreline marsh loss rates; invigorate existing marsh, |

Table 5-4: CWPPRA- Terrebonne Basin (Basin 5)

| TERREBONNE BASIN<br>PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSO | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additional Acres MM | CUMMULATIVE Additional Acres HR | COMMENT | INCLUDED PERMITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Penchant Sub-basin PTE-26 | | F/I/B | Conceptul; needs more study | Better use sediments, fresh water, nutrients | Construct internal/external barriers/shunts; redirect flows/sediments | Slow marsh loss rate, invigorate existing marsh | None | | | | | | 38,553 acres; too few details to apportion to MM or HR; appears efforts to emulate historic flows may also be spring board to manage some areas actively; appears to include formerly and currently mgd areas; assumes mgt of sub-units by individual landowners | |
| Subordinate/componet projects | | | | | | | | | | | | | | |
| * Brady Canal PTE-26b | | F/I/B | 3rd Priority List | Better use sediments, fresh water, nutrients | Construct new perimeter gated culverts/rock weirs; rehab existing levees; manage direct surface flows/ sediment & nutrient inputs | Maintain/invigorate existing marsh; more SAV | NRCS | | 7200 | Act | | 7200 | Effort to emulate natural, historic hydrology but maximum benefit requires additional features/efforts; boat access reduced; creates a semi-isolated marsh | |
| Lake Chapeau PTE-23/ XTE-33 | | B | 3rd Priority List | Reduce tidal scour, better use sediments/nutrients | Construct new perimeter rock weirs in natural and man-made waterways; rehab existing structures; construct new levee | Freshen existing marshes | NRCS | | 15587 | Act | | 15587 | Effort to emulate natural, historic hydrology but maximum benefit requires additional features/efforts; boat access reduced; creates a semi-isolated marsh | |
| Parish Line of Defense XTE-28 | | F/I/B/S | Corresponds to a proposed hurricane protection alignment | Provide hurricane and marsh protection | Construct line of defense with dredged material/perimeter water control structures | Construct hurricane-grade barrier to flooding; reduce storm-induced marsh losses | None | | | Act | | | Permit applied for; concurrently under study by New Orleans Dist., COE as a potential Federal hurriane protection project | |
| Subordinate/componet projects | | | | | | | | | | | | | | |
| * Grand Bayou Wetland TE-5 | | F/I/B | One of two parts already constructed; candidate priority listing | Reduce incidence of salinity-induced stresses | Construct new semi-impoundment; construct new manipulatable structures; construct new & rehab existing levees | Slow marsh loss rate, invigorate existing marsh; vegetate exposable substrates; more SAV | None | 35857 | | Act | 35857 | | Within footprint of XTE-28; could be stand-alone project; targets formerly unmanaged marsh, both public and private | |
| * Pointe Au Chen TE-6 | | B | Engineering by LaDNR | Reduce influence of tidal factors; make better use of available fresh water | Construct new perimeter structures; manage water levels and manage fresh water inputs | Slow marsh loss rate; more SAV | None | 5407 | | Act | 5407 | | Within footprint of XTE-28; could be stand-alone project, regardless of status of XTE-28; targets formerly unmanaged marsh | |
| * Lake Boudreaux TE-7 | | F/I/B | Parts incomplete | Reduce tidal exchange/salt water intrusion; increase water retention | Construct barriers internal to hurricane protection levee; limit exchange; manage surface flow patterns/rates | Slow marsh loss rate; invigorate existing marsh; more SAV | None | | | | | | Partly within footprint of XTE-28; manage marshes isolated by the hurricane protetion levee | |
| TE-7a | | F/I | Permitted | | | | | 5000 | | Act | 5000 | | Within footprint of XTE-28 | (Terrebonne P w/)478; |
| TE-7b | | B | Permitted | | | | | | 3000 | | | 3000 | Within footprint of XTE-28 | (Terrebonne P w/)943; |
| TE-7c | | B | Permitted | | | | | | 1600 | | | 1600 | Within footprint of XTE-28 | (Terrebonne P w/)953 |
| TE-7d | | B | Plan formulation by SCS | | | | | 5888 | | | 5888 | | | |
| * Bayou Pelton Wetland TE-8 | | F/I | Candidate for priority listing | Increase fresh water retention; reduce incidence of salt water intrusion | Construct new perimeter closures and water control strucutres in man-made and natural waterways; elevate natural levee | Slow marsh loss rate; invigorate existing marsh; more SAV/vegetated substrate | None | 2400 | | Act | 2400 | | Within footprint of XTE-28; could be stand-alone project, regardless of status of XTE-28; targets formerly unmanaged marsh; creates semi-impoundment | |

Table 5-4: Continued

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lower Bayou LaCache TE-19 | I/B | 1st Priority List; Permitted | Reduce tidal exchange/salt water intrusion | Reconstruct perimeter levee; construct new perimeter strucutres in man-made waterways; make better use of suppliedfresh water | Protect/invigorate existing marsh; more SAV | NMFS | | 4558 | Act | | 4558 | Abutts footprint of XTE-28; previously permitted; stand-alone project; creates a semi-isolated marsh; includes boat-bay |
| S. Bayou Pelton XTE-56 | B | Candidate for priority listing | Reduce tidal exchange | Plug embankment breaches | Forestall the advent of tidal/ salt water stresses | None | | 2248 | Pass | | 2248 | Abutts footprint of XTE-28; targets previously unmanaged marsh; stand-alone project |
| S. Point Au Chen XTE-57 | B | Candidate for priority fisting | Reduce tidal exchange/salt water intrusion; increase water input/retention | Construct/rehab existing perimeter man-made features; construct new perimeter structures in man-made waterways; use dredged material to creat perimeter marsh | Slow marsh loss rate; invigorate existing marsh; freshen existing marsh; more SAV | None | | 6090 | Pass | | 6090 | Abutts footprint of XTE-28; targets previously unmanaged marsh; stand-alone project; maximum benefit may be contingent upon XTE-28 |
| Grand Bayou-GIWW TE-10/ XTE-49 | F/I | Candidate for priority listing | Change hydrology of sediments/fresh water;, reduce salt water intrusion; make better use of sediments and fresh water | Install diversion structure; redirect flows/sediment | Slow marsh loss rate; invigorate existing marsh; more SAV | None | | * | Act | * | | Apparent major alternative if hurricane protection levee is not installed; attempt emulate natural, historic hydrology but maximum effectiveness depends upon additional structures and effort |
| Subordinate/componet projects | | | | | | | | | | | | |
| * Grand Bayou/Bully Camp XTE-47/ XTE-48 | B | Candidate for priority listing | Reduce tidal exchange/salt water intrusion, more fresh water input/retention | Construct new perimeter strucutres; manage/ surface waters | Slow marsh loss rate; invirorate existing marsh; more SAV | None | 8856 | | Act | 6106 | | Abutts footprint of XTE-28; wholly contained within footprint of TE-10/XTE-49 (southern half); could be installed independently of TE-10/XTE-49; partially overlaps XTE-25; targets formerly unmanaged marsh |
| * Bully Camp TE-9 | B | Candidate for priority listing | Control surface water depths/quality | Construct new perimeter structures; manipulate water levels | Slow marsh loss rate; protect inland marshes | None | 750 | | Act | 750 | | Wholly contained within footprint of TE-10/XTE-49; could be installed independently of TE-10/XTE-49; targets formerly unmanaged marsh |
| * S. Bully Camp XTE-58 | B | Candidate for priority listing | Make better use of divertable fresh water; use dredged material to reclaim eroded substrates | Construct new perimeter weirs and plugs in natural & man-made waterways; install new culverts; maintain existing levees; use dredged material to reclaim eroded substrates | Slightly freshen marshes | None | | 18206 | Pass | | 18206 | Extends beyond footprint of XTE-28; stand-alone project; targets formerly unmanaged marsh, both public and private |
| * Bayou Blue Water Mgt PTE-25 | B | Candidate for priority listing | Change hydrology of fresh water | Construct new perimeter structures; redirect flows; prolong freshe water retention time | Slow marsh loss rate; invigorate marsh | None | | 18350 | Act | | | Abutts footprint of XTE-28; partially XTE-47/48 and comprises nearly the entire eastern half of TE-10-XTE-49 |

Table 5-4: Continued

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S. Wonder Lake<br>XTE-60 | B | Candidate for priority listing | Protect remnant marsh | Construct line of defense; place structures in man-made and natural waerways | Slow marsh loss rate; more SAV | None | | 11080 | Pass | | 7222 | Abutts footprint of XTE-28; targets formerly unmanagd marsh; a stand-alone project | |
| Subordinate/componet projects | | | | | | | | | | | | | |
| * Wonder Lake<br>XTE-29 | B | Plan formulation | Control surface water depths/quality | Construct/rehab existing barriers; conduct water level reductions | Slow marsh loss rate; invigorate remnant marsh | None | 3858 | | Act | 3858 | | Abutts footprint of XTE-28; targets formerly umnaged marsh; a stand-alone project that is also wholly contained within footprint of XTE-60; further compartmentalizes the marsh | |
| S. Falgout Canal<br>XTE-55 | B | Candidate for priority listing | Reduce salt water intrusion; better use of avialable water | Construct new/rehab existing structures; periodically input fresh water | Slow marsh loss rate; invigorate existing marsh, more SAV | None | | 12266 | Pass | | 12266 | Targets previously unmanged marsh; (Terrebonne P w/)822 of the Hurricane Protection Project | (Terrebonne P w/)49<br>(Terrebonne P w/)8<br>both no work/expre |
| S. Fina LaTerre<br>XTE-59 | B | Candidate for priority listing | Off-set man-made isolation | Construct new structures; manage inflows | Slow marsh loss rate | None | | 4544 | Pass | | 4544 | Targets previously unmanged marsh; maximum benefits depend upon installation of the HurricaneProtection Project | Adjoins<br>(Terrebonne P w/)6 |
| Point Au Fer Canal Closures<br>PTE-22/24 | B | 2nd Priority List | Reduce salinity/tidal flux | Construct/reinforce barriers in man-made canals | Create defensive line; slow marsh loss rate | NRCS | | 5230 | Pass | | 5230 | Effort to emulate natural, historic hydology | |
| N=21 | | | | | | Sub-totals | 68016 | 109959 | | 67266 | 87751 | | |
| | | | | | | Totals | 177975 | | | | | | 155017 |

IN CWPPRA BASIN 5 PLAN BUT NOT INCLUDED IN PMMEIS

| | | | | | | |
|---|---|---|---|---|---|---|
| Stormwater Mgt<br>PTE-19 | ? | Candidate for priority listing | Make better use of fresh water/nutrients from pumped areas | Manage pump discharges, construct barriers, increase fresh water retention time | Slow marsh loss rate | None |

Table 5-5: CWPPRAA- Teche-Vermilion Basin (Basin 7)

| TECHE/VERMILION BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSO | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additional Acres MM | CUMMULATIVE Additional Acres HR | COMMENT | INCLUDED PERMITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shark Island TV-1 | | B | 1st Priority List | Reduce ponding/salt build-up in interior marshes, slow/halt shoreline erosion | Construct new perimeter structures; armor bankline | Slow internal marsh loss rate, shoreline erosion rate | NRCS | | 2181 | Act | | 2181 | Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; control exchange at man-made waterways only | |
| Cote Blanche TV-4 | | F | 3rd Priority List | Reduce erosive tidal action in interior marshes; better use available sediments; slow/halt shoreline erosion | Construct new perimeter structures; cut gaps, armor bankline | Slow internal marsh loss rate, shoreline erosion rate | NRCS | | 30000 | Act | | 30000 | Shoreline erosion control efforts are wholly separate, unrelated project components relative to hydrologic restoration; construct rock weirs in man-made and natural waterways | St. Mary Ph wl 153 |
| Marsh Island Canals TV-5/7a | | B | Candidate for priority listing | Reduce tidal action, protect shoreline | Upgrade existing water control structure, armor bankline | Slow marsh loss/shoreline/ lake rim erosion rates, invigorate existing marsh | None | | 6697 | Pass | | 6697 | Shoreline erosion control/lake rim protection efforts are separate, unrelated project components relative to hydrologic restoration; plug only oil field canals | |
| Redfish Pt. TV-8 | | B | Candidate for priority listing | Reduce erosive tidal action in internal marsh; slow/halt shoreline erosion | Restore/upgrade existing water management capability; slow/ halt shoreline erosion | Reacquire/prolong management capability; slow/halt shoreline erosion rate | None | | 400 | Act | | 400 | Shoreline erosion control/lake rim protection efforts are separate, unrelated project components relative to management of the marsh | |
| N=4 | | | | | | | Sub-totals | 0 | 39278 | | | 39278 | | |
| | | | | | | | Total | 39278 | | | | | | |
| IN CWPPRA BASIN 7 PLAN BUT NOT INCLUDED IN PMMEIS | | | | | | | | | | | | | | |
| Vermilion Bay Pipeline Plugs PTV-11 | | | Candidate for priority listing; not site specific | Reduce tidal exchange in interior marshes | Install barriers | Slow marsh loss rate | None | | | | | | | |
| Weeks Bay-GIWW HR/SP TV-10 | | | Candidate for priority listing | Use dredged material to recreate marsh/protect shoreline | Construct perimeter retention dikes, deposit backfill | Create marsh, reclaim land, protect shoreline | None | | 2683 | | | 2683 | | |

Table 5-6: CWPPRA- Mermentau Basin (Basin 8)

| MERMENTAU BASIN<br>PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSOR | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additonal Acres MM | CUMMULATIVE Additonal Acres HR | COMMENT | INCLUI PERMI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sawmill Canal Structure PME-14 | | F/I/Smp | Candidate for priority listing | Maintain existing mgt capablilities to control water levels, salinity | Rehab/upgrade existing structures/barriers | Sustain/enhance biological productivity of currently managed area | None | | 2742 | Act | | 0 | Perpetuates semi-impoundment management capability | |
| Humble Canal Structure PME-15 | | F/I | Candidate for priority listing | Reestablish prior mgt capability to control water levels | Replace existing failed structure | Reacquire ability to affect biological productivity of managed area for resident fish and wildlife | None | | 5500 | Act | | 0 | Targets interior marshes; reestablishes semi-impoundment condition | |
| Coteau Plateau MM PME-16 | | F/I | Conceptual, may be candidate for priority listing | Reduce stressors; move to a site-specific rather than a large area water level/chemistry management capability | Install new structures | Enhanced productivity; halt land loss | None | 7300 | | Act | 7300 | | Creates a site-specific water level/chemisry mgt capability; ends reliance upon a more distant structure; creates a semi-impoundment | |
| N. Little Pecan Bayou XME-40 | | I | May be candidate for priority listing | Maintain existing mgt capabilities to control water levels, salinity | Preventative maintenance & upgrade of existing water control structures | Sustain/enhance biological productivity of managed area; protect/invigorate existing marsh; more SAV | None | | 4467 | Act | 0 | 0 | Targets interior marshes; perpetuates semi-impoundment management capability | |
| Pumpkin Ridge Structure XME-45 | | I/B | May be candidate for priority listing | Reestablish prior protection; upgrade management capability; reduce salinity | Replace existing failed structure | Reacquire ability to affect biological productivity of managed area; reduce marsh loss; more SAV | None | | 1000 | Act | 0 | 0 | Targets interior marshes | |
| Rollover Bayou Structure XME-46 | | B/S | May be candidate for priority listing | Reestablish prior protection capability; reduce salinity | Replace existing failed structure | Reacquire ability to affect biological productivity of managed area | None | | 400 | Pass | 0 | 0 | Targets interior marshes; includes boat bay | |
| | | | | | | | Sub-total Totals | 7300 | 14109 | | 7300 | 0 | | |

Table 5-6: Continued

IN CWPPRA BASIN 8 PLAN BUT NOT INCLUDED IN PMMEIS

| | | | | |
|---|---|---|---|---|
| Hog Bayou Wetland MM ME-2 | B/S | One-time candidate for priority listing; Federal permit denied | Decouple targeted marsh to foster establishment of brackish marsh at expense accreting saline marsh | Create semi-impoundment with barriers; intensively manage exchanages to convert accreting saline marsh to barckish marsh |
| Warren Canal Structure | F | Conceptual, requires more study | Protect upstream agricultural interests, facilitate more estuarine organism access elsewhere | Install new structure internal to basin boundary |
| Seventh Ward Canal Structure XME-27 | F | Conceptual, requires more study | Protect upstream agricultural interests, facilitate more estuarine organism access elsewhere | Install new structure internal to basin boundary |
| Florence Canal XME-43 | F | Conceptual, may be candidate for priority listing | Reduce shoreline erosion | Levee restoration |
| Miami South Levee PME-08 | F/I | Conceptual, may be candidate for priority listing | Reduce flooding of chenier ridge areas; aide in water level control | Construct 50,000 ft. of new levee |
| Mud Lake Levee XME-39 | I | Conceptual, may be candidate for priority listing | Prevent saltwater intrusion | Levee restoration |
| Grand Chenier Levee HR XME-41 | F | Conceptual, may be candidate for priority listing | Flood protection of chenier ridge; inhibit salt water intrusion | Restore 2.5 miles of existing levee; no estimate of size of impacted area |

Table 5-7: CWPPRA- Calcasieu-Sabine Basin (Basin 9)

| CALCASIEU/SABINE BASIN PROJECT NAME & NUMBER IN CWPPRA BASIN PLAN | MARSH TYPE PAST | MARSH TYPE NOW | STATUS | CWPPRA PROJECT CONCEPT | CWPPRA PROJECT STRATEGY | CWPPRA EXPECTED RESULT | FEDERAL SPONSOR | CWPPRA ACRES MM | CWPPRA ACRES HR | H2O MGT | CUMMULATIVE Additional Acres MM | CUMMULATIVE Additional Acres HR | COMMENT | INCLUDED AREAS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East of Calcasieu Lake | | | | | | | | | | | | | | |
| Highway 384 PCS-25 | | F/I | 2nd Priority List | Reduce influence of Calcasieu Lake | Construct new & rehab existing structures; create barriers to free water exchange | Create conditions more favorable to marsh/aquatic plant growth; more SAV | NRCS | | 650 | Act | | 650 | Variation of PCS-12/18 relative to historic sources; formerly managed area | |
| Tripod Bayou CS-14 | | B | Conceptual state-level project; candidate for priority listing | Improve hydrology in SW corner of Cameron-Creole watershed project; reduce local influence of Calcasieu Lake | Impose new controls to free water exchange | Establish/maintain water levels conditions more favorable to marsh plant growth | FWS | 1186 | | Act | 0 | | Already managed under permit; designed to relieve problem created/associated with the permitted action | (Calcasieu Lake)38 |
| Grand Lake Ridge CS-10 | | B | Conceptual state-level project; candidate for priority listing | Reacquire/upgrade of former mgt capability; reduce water level fluctuation and incidence of saltwater intrusion | Create one semi-impoundment, vegetate exposable substrates; create another area mgd area influenced by a rock weir | Establish/maintain water level/chemistry conditions more favorable to marsh plant growth; more SAV | None | 1462 | | Act | 1462 | | Conceptual state project; two mgt cells - one mgd actively, one mgd passively | |
| West of Calcasieu Lake | | | | | | | | | | | | | | |
| ***Southwest Calcasieu Lake*** | | | | | | | | | | | | | | |
| Structures - Oyster & Mud Bayous PCS-12/18 | | B | Component of C/S Basin Plan; candidate for priority listing | Reduce tidal scour, water level fluctuations and incidence of saltwater intrusion | Impose new controls to free water exchange | Establish/maintain water level/chemistry conditions more favorable to marsh plant growth | None | | 7560 | Pass | | 7560 | Unspecified structure design; supports C/S perimeter protection plan; designed to affect interior marsh areas; includes portion of (Oyster Bayou)7; effort to emulate inputs/surface flow patterns relative to historic sources; boat access a consideration | |
| * Oyster Bayou/Lake Unit XCS-48 (SO-6) | | I/B | Component of C/S Basin Plan; awaits feasibility study; may be candidate for priority listing | | | | None | | | | | | Variation of PCS-12/18 | |
| W. Mud Lake XCS-48 (SO-5) | | F/I | Component of C/S Basin Plan; candidate for priority listing | Reduce water levels; promote better internal circulation; upgrade of existing mgt capability | Add a variable crest weir to an existing structure & adjust invert of other existing culverts to better control water exchange | Reestablish/maintain water level conditions more favorable to marsh plant growth | None | 12007 | | Act | 0 | | Designed to affect interior marsh areas; can influence hydrology/water chemistry/operational criteria in PCS-24, East Mudd Lake MM area controlled by active mm structure (XCS-48N) | |
| East Mud Lake PCS-24 | | B | 1st Priority List | Reduce/control water levels/ chemistry | Upgrade existing/construct new water control structures | Slow marsh loss/shoreline erosion rates, more SAV, invigorate existing marsh, vegetate eroded/exposable | NRCS | 8054 | | Act | 0 | | Revised version of (Cameron P w/) 923 (dated 3/26/92) permitted nearly identical project | |

Table 5-7: Continued

substrates

***West-central Calcasieu Lake***

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Cove Canal Plug XCS-44 | | B | Candidate for priority listing | Affect movement pattern of tidal water | Construct a new plug | Reestablishes West Cove Canal integrity | None | | 6368 | Pass | 6368 | Supports C/S basin permimeter protection plan; restores hydrology of canal system | |
| Replace Refuge Structures XCS-47/ 48i,j,k&p | | B | 3rd Priority List | Prolongation/added flexibility of current mgt capability | Replace/upgrade existing structures | Re-establish/maintain water level conditions more favorable to marsh plant growth | FWS | 41857 | | Act | 0 | Supports C/S basin permimeter protection plan but designed to affect interior marshes, including a big part of Sabine NWR; potential to increase fisheries access; greater water level/chemistry control | part of (Cameron P w/)863 all of (Cameron P w/)863 |
| No. Line Canal Structure XCS-46 | | F/I | Candidate for priority listing | Recreate hydrologic boundary between Sabine & Calcasieu basins; enhance flexibility effectiveness of eastern refuge structures | Construct barrier to E-W water movement | Emulates historic internal boundary between Sabine and Calcasieu basins | None | | 27453 | Pass | 27453 | A stand-alone project, but also closes hydrologic back door for Refuge and Rycade Canal structures, thus component of perimeter control control strategy; structure design uncertain | |
| Browns Lake/Starks Canal XCS-48 (SA-1) | F | I | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee | Prolongs/improves mgt capability for waterfowl and freshwater fisheries | None | 4100 | | Act | 0 | Upgrade of continuously managed refuge area; a stand-alone project unrelated to any other project in basin; controlled by active mm structure (XCS-48l); listed as sediment trapping | |
| S. Browns Lake-E. Hog Island Gully XCS-48 (SA-1a) | F/I | B | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee, upgrade structures | Prolongs/improves mgt capability for waterfowl and freshwater fisheries | None | | 5138 | Act | 0 | Upgrade/preventative maintenance of continiously managed Refuge impoundment recently placed under pump | |
| E. Back Ridge Canal XCS-48 (SA-1b) | F/I | I | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee, upgrade structures | Prolongs/improves mgt capability for waterfowl and freshwater fisheries | None | | 1961 | Act | 0 | Upgrade/preventative maintenance of continiously managed Refuge impoundment recently placed under pump | |
| S. Back Ridge XCS-48 (SA-2) | F/I | I/B | Candidate for priority listing | Prolongation of existing management capability | Maintain integrity of existing perimeter levee system | Reduces the potential for marsh loss due to levee failure | None | | 7552 | Act | 0 | Prolongation of existing management capability of Refuge impoundment | |

Table 5-7: Continued

***Northwest Calcasieu Lake***

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Browns Lake CS-9 | I | B | 2nd Priority List | Create management capability; control water depth/chemistry | Construct semi-impoundment | Create/maintain conditions more favorable to marsh/ aquatic plant growth; more SAV; possibly vegetate eroded/exposable substrate | None | 2800 | | Act | 2800 | Until constructed, area will be influenced by the Alkali Ditch structure. Once built, area will function independently from any other area in the basin | |
| Alkali Ditch Structure XCS-53 | B | B | Candidate for priority listing; essential component of CWPPRA perimeter protection | Reduce infleunce of major connection with Calcasieu Lake via GIWW | Construct new partial barrier to free water exchange | Create condiditons more favorable to marsh/aquatic plant growth | None | | 14500 | Pass | 14500 | Supports C/S basin permimeter protection plan; designed to affect interior marshes, effects encompass NO-1, NO-2a and NO-5; structure includes a boat bay | |
| Subordinate/component projects | | | | | | | | | | | | | |
| * N. Blk. Lake CS-8/ XCS-48 & (NO-2a) | I | B/S | Candidate for priority listing | Reacquire mgt capability | Reconstruct barriers to free water exchange | Create conditions more favorable to marsh/aquatic plant growth; more SAV/ vegetated eroded/exposable substrate | None | 795 | | Act | 795 | Formerly leveed private wetland; (Cameron P w/) 30 (dated xx/x/xx) permitted nearly identical project; Until constructed, area will be influenced by the Alkali Ditch structure. Once built, area will function independently from any other area in the basin | (Black Lake)30 |
| * S. Brown Lake XCS-48 (NO-5) | B | B | See XCS-53 | See XCS-53 | See XCS-53 | Create conditions more favorable to marsh/aquatic plant growth; more SAV/ vegetated eroded/exposable substrate | None | | 6300 | Pass | 6300 | Residual area affected by proposed Alaki Ditch Structure | |
| NE. Blk. Lake XCS-48 (NO-2) | I/B | I/B | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee, upgrade structures | Prolongs/improves mgt capability for waterfowl and freshwater fisheries; vegetate eroded, exposable substrates; more SAV | None | 1359 | | Act | 0 | Upgrade of continuously managed private area | Cameron P w/)832 |
| W. Blk. Lake XCS-48 (NO-4) | F/I | I | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee, upgrade structures | Prolongs/improves mgt capability; more SAV; vegetate eroded, exposable substrates | None | 5342 | | Act | 0 | Upgrade of continuously managed private area; (Cameron P w/) 744 (dated xx/xx/xx) permitted nearly identical project | Cameron P w/)744 |
| Rycade Canal Structure CS-2 | F/I/B | F/I/B | Installed; essential component of CWPPRA perimeter protection | Reduce infleunce of major connection with Calcasieu Lake | Construct adjustable barrier to free water exchange | Create conditions in interior areas favorable to marsh/aquatic plant growth | None | | 10000 | Act | 4600 | Essential component of basin permimeter protection plan until Alkali Ditch structure is built; thereafter, reduced to strategically located internal structure providing basis for more intensive mgt efforts of internal marshes | |
| Subordinate/component projects | | | | | | | | | | | | | |
| * SW Black Lake XCS-48 (NO-8) | F/I/B | B | Candidate for priority listing | Prolongation/added flexibility of current mgt capability | Maintain integrity of existing perimeter levee, install structures | Prolongs/improves mgt capability; invigorate existing marsh | None | 11700 | | Act | 0 | Until implemented, affected by Rycade Canal structure; upgrade of continuously managed private area; to be managed for fresher marsh type | Cameron P w/)963 |
| Kelso Bayou Structure PCS-14 | B | B | Candidate for priority listing; componet of CWPPRA perimeter protection plan | Reduce infleunce of major connection with Calcasieu Lake | Construct new partial barrier to free water exchange in a natural waterway | Targets previously unmanaged marsh; create conditions in interior areas more favorable to marsh/aquatic plant growth | None | | 2500 | Pass | 2500 | Supports C/S basin permimeter protection plan; designed to affect interior marshes; potential separate project; but reduced exchange increases effect of Alkali Ditch/Rycade Canal structures and included | |

Table 5-7: Continued

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | managed area; includes boat bay |
| ***Northeast Sabine Lake*** | | | | | | | | | | | | | |
| Starks Bayou XCS-48 (NO-14a) | I | I/B | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct several rock weirs; increase sediment retention; reduce salinity levels | Conversion of some saltier marsh to fresher forms | None | | 3500 | Pass | | 3500 | Targets formerly unmanaged interior marsh; a stand-alone project; creates a semi-isolated marsh area; could receive wate discharges from NO-14 |
| GIWW/Black Bayou Marsh CS-5a/12 | F/I/B | F/I | Candidate for priority listing; part of State plan; feasibility study complete | Reduce estuarine influences, tighten hydrologic boundaries; better use supplied fresh water; many structures componenets of perimeter protection strategy | Construct a series of perimeter and internal structures (adjustable and fixed) to control exchanges between and the retention time of introduced freshwater within management units | Create conditions in interior areas more favorable to marsh/aquatic plant growth | None | | 28000 | Act | | 4090 | Supports C/S basin permimeter protection plan; attempts to emulate historic fresher water inputs; relies upon a collection of several often interdependent projects to emulate historic fresher water conditions in perimeter and interior marshes; maintaining boat access will be considered |
| Subordinate/component projects | | | | | | | | | | | | | |
| * W. Gum Cove/ Black Bayou XCS-48 (NO-14) | I | F/I | Candidate for priority listing; design incomplete | Reduce water level fluctuation; erosive tidal scour and incidence of saltwater intrusion | Construct rock weirs at natural exchange points to control surface slows | Prolong existing marsh type in interior area | None | 4200 | | Pass | 4200 | | Targets formerly unmanaged interior marsh; a potential stand-alone project; creates a semi-isolated marsh area; within footprint of and includes componet strucutres of CS-5a/12; infusion of fresh water may intensify response; discharges water to NO-14a |
| * Blk. Bayou Cutoff XCS-48 (NO-15) | F/I | F/I | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct new in/rehab existing structures/levees that define the hydrologic boundaries on 3 sides of the targeted area | Prolong existing marsh type | None | | 621 | Pass | | 621 | Targets formerly unmanaged perimeter marsh; a potential stand-alone project; within footprint of and includes componet structures of CS-5a/12; infusion of fresh water may intensify response |
| * NW Black Bayou XCS-48 (NO-17) | F/I | F/I | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct 2 rock weirs in exchange points along a man-made waterway; rehab existing levee | Prolong existing marsh type; increase sediment retention | None | | 3300 | Pass | | 3300 | Targets formerly unmanaged perimeter marsh; a potential stand-alone project; within footprint of and includes componet structures of CS-5a/12; includes XCS-48d (NO-17; creates a semi-isolated marsh area; infusion of fresh water may intensify response; culvert delivers water to NO-18 |
| * SE Black Bayou XCS-48 (NO-18) | I | I/B | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct 22 rock weirs in natural exchange points | Conversion of some saltier marsh to fresher forms | None | | 4422 | Pass | | 4422 | Targets formerly unmanaged interior marsh; a potential stand-alone project; within footprint of and includes componet structures of CS-5a/12; creates a semi-isolated marsh area; infusion of fresh water may intensify response; culvert delivers water to NO-19 |
| * Black Bayou XCS-48 (NO-19) | I | I/B | Candidate for priority listing; part of C/S River Basin Study | Reduce incidence of high salinity events, winter droughts & wave erosion in open water areas | Construct 1 rock weir/1 plug in man-made exchange points; install wave breaks/sediment retention features in internal open water area | Conversion of some saltier marsh to fresher forms; more SAV; reduce wave-induced erosion of open water shorelines | None | | 9677 | Pass | | 9687 | Targets formerly unmanaged perimeter marsh; a potential stand-alone project; within footprint of and includes componet structures of CS-5a/12; infusion of fresh water may intensify response |
| * W. Blk. Bayou XCS-48 (NO-20) | B | I/B | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct 5 rock weirs in natural exchange points | Conversion of some saltier marsh to fresher forms; more vegetated surface; invigorate existing vegetation | None | | 1700 | Pass | | 1700 | Targets formerly unmanaged interior marsh; a potential stand-alone project; within footprint of and includes componet structures of CS-5a/12; creates a semi-isolated marsh area; infusion of fresh water may intensify response |
| SW Blk. Bayou XCS-48 (NO-21) | F/I | B | Candidate for priority listing; part of C/S River Basin Study | Reduce water level fluctuation and incidence of saltwater intrusion | Construct 12 rock weirs in natural exchange points; a plug in a man-made waterway; install wave breaks/sediment retention features in internal open water area | Conversion of some saltier marsh to fresher forms; more vegetated surface; invigorate existing vegetation | None | | 6225 | Pass | | 6225 | Supports C/S basin permimeter protection plan; targets formerly unmanaged perimeter marsh; potential separate project; part of Sabine NWR |
| NW Gum Cove XCS-48 (NO-13) | F/I | I | River Basin Study listing; part of C/S River Basin Study | Reacquire/upgrade of former mgt capability | Reconstruct barriers to control water exchange | Create conditions more favorable to marsh/aquatic plant growth; convert to fresh marsh | None | | 4100 | Act | | 0 | Upgrade of formerly managed area |

Table 5-7: Continued

***East-central Sabine Lake***

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| GIWW-Sabine River Rock Weirs PCS-10 | | I/B | Candidate for priority listing; part of C/S River Basin Study; component ofCWPPRA perimeter protection plan | Reduce water level fluctuation and incidence of saltwater intrusion | Construct rock weirs in man-made exchange points | Create conditions more favorable to marsh/aquatic plant growth | | 1680 | Pass | 1680 | Critical component of C/S basin plan; targets formerly unmanaged perimeter marsh; potential separate project; creates semi-isolated marsh area |
| Sabine Lake Closures PCS-11 | F/I/B | B | Candidate for priority listing; part of C/S River Basin Study; integral component of CWPPRA perimeter protection plan | Reduce water level fluctuation and incidence of saltwater intrusion | Construct several new perimeter structures in man-made water ways | Invigorate existing marsh; reduce marsh loss rate | | 600 | Pass | 600 | Includes some XCS-48(SA-7) structures (unspecified design and area of effect); a boat bay will be considered; targets Sabine NWR holdings |
| Pool 3 Unit XCS-48 (SA-3) | F | F | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Generally reduce water levels/ erosive effects of wind-generated waves | Increase water level reduction capability; increase sediment retention; reduce wave action on interior marsh shorelines | Maintain extent of current marsh type; invigorate existing marsh; more SAV | 26356 | | Act | 0 | Targets a continuously actively managed internal marsh of Sabine NWR; potential stand-alone project; listed as sediment trapping effort |
| Old N. Bayou Unit XCS-48 (SA-4) | F/I | I | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Generally reduce water levels/ erosive effects of wind-generated waves | Increase water mgt capability; increase sediment retention; reduce wave action on interior marsh shorelines | Continued natural expansion of intermediate marsh types | 13614 | | Act | 0 | Continuously managed portion of Sabine NWR; targets internal marsh; linked to SA-3 strucutres; listed as sediment trapping effort |
| Greens Lake XCS-48 (SA-5) | F/I/B | I/B | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Simulate former surface water flow patterns; reduce incidence of salt water intrusion/water levels/ erosive effects of wind-generated waves | Install structures in natural and man-made waterways; redirect internal surface flow patterns; increase sediment retention; reduce wave action on interior marsh shorelines | Invigorate existing marsh; reduce marsh loss rate | | 23100 | Act | 23100 | Targets formerly managed marsh in Sabine NWR; supports C/S perimeter protection plan; potential stand-alone project |
| S. Willow Bayou XCS-48 (SA-7) | I/B | I/B | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Generally reduce water levels/ erosive effects of wind-generated waves in internal open water area | Reacquire/upgrade water mgt capability; increase sediment retention, reduce wave action on interior marsh shorelines; redirect internal surface flow patters | Invigorate existing marsh; reduce marsh loss rate; more SAV | | 5610 | Act | 5610 | Targets formerly unmanaged perimeter marsh; emulates historic surface flow patterns; maximum benefit from structure used to control water level; potential stand-alone project; part of Sabine NWR |
| Deep Lake Bayou Unit XCS-48 (SA-6) | F | I/B | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Reduce incidence of salt water intrusion; reduce erosive effect of wind-generated waves | Structures installed in surrounding units will provide protection against salt water; reduce wave action on interior marsh shorelines | Invigorate existing marsh; stimulate marsh expansion; more SAV | | 2000 | Pass | 2000 | Targets formerly unmanaged interior marsh; success/benefits depend upon installation of adjacent projects; part of Sabine NWR; listed as sediment trapping |

Table 5-7: Continued

***Southeast Sabine Lake***

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Johnson's Bayou XCS-48 (SO-1) | I/S | I/B | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Reduce water level fluctuation and incidence of saltwater intrusion; increase freshwater retention | Construct 16 rock weirs, 14 plugs in natural and man-made waterways | Reduction of brackish marsh acreage; expansion of intermediate marsh acreage; invigorate marsh; more SAV | | | 30585 | Pass | | 30585 | Targets formerly unmanaged perimeter marsh; a potential stand-alone project; some attempt to emulate historic surface water patterns; seems to create a semi-isolated marsh area |
| South Unit (SO-1a) | B | I/B | Not a CWPPRA candidate project; component of C/S River Basin Plan | Convert existing healthy marsh types to fresher types | Maintain existing levee; construct variable-crest weirs with flap-gated culverts | Ability to manage for fresh and intermediate marsh types | | | 3950 | Act | | 0 | Targets currently managed marsh; stand-alone project; no apparent surface connection to tidal waters |
| SW Johnson's Bayou XCS-48 (SO-2) | B/S | I/B | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Create conditions conducive to perpetuating current marsh types; reduce incidence of salt water intrusion, water level fluctuations | Construct rock weir in natural exchange point at lake rim, and two more structures (unspecified type) upstream from the rock weir specifically to protect an area of intermediate marsh; construct shoreline protection | Prolongation of existing types/acreages; invigorate existing marsh; more SAV | | | 30585 | Pass | | 30585 | Targets formerly unmanaged marsh; a potential stand-alone project; acreage affected may be overstated; listed as shore protection |
| Four Mile Square XCS-48 (SO-4) | I/B | I | Candidate for priority listing; part of C/S River Basin Study; planning incomplete | Prolong/upgrade existing management capability | Increase water level mgt capability | Maintain/invigorate current marsh types, vegetate exposable marsh substrates | | | 6800 | Act | | 0 | Targets currently managed marsh; stand alone project |
| | | | | | | | Totals | 132032 | 250237 | | 6457 | 200416 | |

Table 5-7: Continued

IN CWPPRA BASIN 9 PLAN BUT NOT INCLUDED IN PMMEIS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Black Bayou CS-12 | See CS-5a/12 | | | | | | | |
| Cameron-Creole Plugs PCS-17 | Internal to Cameron-Creole Mgd. Area | | | | | | | |
| Brannon Ditch Barrier PCS-31 | | | | | | | | |
| Long Pt. Bridge Srtructure XCS-48f | | | | | | | | |
| Bayou Peconi Plug XCS-52 | Conceptual | | | | | | | |
| Goose Lake XCS-54 | Abuts but outside northern basin boundary | | | | | | | |
| O&M - Cameron Creole CS-4a/ PCS-7 | Operation & Maintence of existing, operable management strucutres | | | | | | | |
| Moss Lake PCS-21 | Outside basin boundary | | | | | | | |
| Rock Line - West Cove XCS-48o | Channel stabilization | | | | | 2400 | Pass | |
| Ship Channel Spoil Mining/Canal Plug XCS-51/44 | Minor variation of XCS-44 | | | | | | | |
| Northwest Cove XCS-48 (SA-8) | Another project to upgrade Refuge structures included in XCS-48i,j,k,p | | | | | | | |
| Browns Lake/ Starks Canal XCS-48 (SA-1) | Nearly identical effects of XCS-47/48 i,j,k & p | | | | | | | |
| Deep Lake XCS-48 (SA-6) | Candidate for future consideration; part of River Basin Study but | Maintain existing surface water exchanges/flow patterns | Stabilize existing conditions | Guard against wind-induced shoreline erosion; expansion of marsh vegetation | None | 2000 4600 | 4600 | Historically unmanged unit of Sabine NWR |
| W Cove Canal XCS-48 (SA-10) | Structure modification included in XCS-47/48, i,j,k & p; but could be individual project | | Construct barrier to free free exchange | Eliminates direct link with Calcasieu Ship Channel; Improves control over surface water/salinity/ flowage in marshes to west | | | | Project includes upgrade of one Refuge strucutre; little or no effect on lake-rim marsh |

Table 5-8: CWPPRA

| Marsh Type | BASIN 1: Pontchartrain Hydrologic Restoration New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | 1 Marsh Management New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | 0 | 0 | 0 | 0 | 8000 | 0 | 0 | 0 | 0 | 0 | 8000 |
| I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I | 5924 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5924 |
| F/I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 1289 | 0 | 0 | 3915 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5204 |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 7213 | | 0 | | 0 | | 8000 | | 0 | | 0 | | 15213 |
| Passive | | 0 | | 3915 | | 0 | | 0 | | 0 | | 0 | 3915 |
| New | 7213 | | | | | | 8000 | | | | | | 15213 |
| Rehab | | | 3915 | | | | | | 0 | | | | 3915 |
| N & R | | | | | 0 | | | | | | 0 | | 0 |
| HR | 11128 | | | | | | | | | | | | |
| MM | 8000 | | | | | | 8000 | | | | | | |
| Basin Total | 19128 | | | | | | | | | | | | |
| Delta Total | 258114 | | | | | | | | | | | | |
| Chenier Total | 214173 | | | | | | | | | | | | |
| Coast Total | 472287 | | | | | | | | | | | | |

Table 5-9: CWPPRA

| Marsh Type | BASIN 4: Barataria Hydrologic Restoration New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | 4 Marsh Management New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | 0 | 0 | 6450 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6450 |
| I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I | 0 | 3994 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3994 |
| F/I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 3300 | 0 | 38887 | 0 | 0 | 0 | 0 | 0 | 2548 | 0 | 0 | 0 | 44735 |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 3300 | | 38887 | | 6450 | | 0 | | 2548 | | 0 | | 51185 |
| Passive | | 3994 | | 0 | | 0 | | 0 | | 0 | | 0 | 3994 |
| New | 7294 | | | | | | 0 | | | | | | 7294 |
| Rehab | | | 38887 | | | | | | 2548 | | | | 41435 |
| N & R | | | | | 6450 | | | | | | 0 | | 6450 |
| HR | 52631 | | | | | | | | | | | | |
| MM | 2548 | | | | | | 2548 | | | | | | |
| Basin Total | 55179 | | | | | | | | | | | | |

Table 5-10: CWPPRA

| Marsh Type | BASIN 5: Terrebonne Hydrologic Restoration NW Active | Passive | RE Active | Passive | NW+RE Active | Passive | 5 Marsh Management NW Active | Passive | RE Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I | 0 | 0 | 0 | 0 | 0 | 0 | 5000<br>2400 | 0 | 0 | 0 | 0 | 0 | 5000 |
| F/I/B | 0 | 0 | 0 | 0 | 7200 | 0 | 0 | 0 | 0 | 0 | 35857 | 0 | 43057 |
| I/B | 0 | 0 | 0 | 0 | 4558 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4558 |
| B | 0 | 7222 | 0 | 2248 | 15587 | 6090<br>18206<br>12266<br>4544<br>5230 | 8106<br>750<br>3858 | 0 | 0 | 0 | 5407 | 0 | 89514 |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 0 | | 0 | | 27345 | | 20114 | | 0 | | 41264 | | 88723 |
| Passive | | 7222 | | 2248 | | 46336 | | 0 | | 0 | | 0 | 55806 |
| New | 7222 | | | | | | 20114 | | | | | | 27336 |
| Rehab | | | 2248 | | | | | | 0 | | | | 2248 |
| N & R | | | | | 73681 | | | | | | 41264 | | 114945 |
| HR | 83151 | | | | | | | | | | | | |
| MM | 61378 | | | | | | 61378 | | | | | | |
| Basin Total | 144529 | | | | | | | | | | | | |

Table 5-11: CWPPRA

| Marsh Type | BASIN 7: Teche-Vermilion Hydrologic Restoration New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | 7 Marsh Management New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 30000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30000 |
| I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 2181 | 0 | 6697<br>400 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9278 |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 32181 | | 7097 | | 0 | | 0 | | 0 | | 0 | | 39278 |
| Passive | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | 0 |
| New | 32181 | | | | | | 0 | | | | | | 32181 |
| Rehab | | | 7097 | | | | | | 0 | | | | 7097 |
| N & R | | | | | 0 | | | | | | 0 | | 0 |
| HR | 39278 | | | | | | | | | | | | |
| MM | 0 | | | | | | | | | | | | |
| Basin Total | 39278 | | | | | | | | | | | | |

Table 5-12: CWPPRA

| Marsh Type | BASIN 8: Mermentau Hydrologic Restoration New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | 8 Marsh Management New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F/I | 0 | 0 | 0 | 0 | 0 | 0 | 7300 | 0 | 0 | 0 | 0 | 0 | 7300 |
| F/I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| I/B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 0 | | 0 | | 0 | | 7300 | | 0 | | 0 | | 7300 |
| Passive | | 0 | | 0 | | 0 | | 0 | | 0 | | 0 | 0 |
| New | 0 | | | | | | 7300 | | | | | | 7300 |
| Rehab | | | 0 | | | | | | 0 | | | | 0 |
| N & R | | | | | 0 | | | | | | 0 | | 0 |
| HR | 0 | | | | | | | | | | | | |
| MM | 7300 | | | | | | | | | | | | |
| Basin Total | 7300 | | | | | | | | | | | | |

Table 5-13: CWPPRA

| Marsh Type | BASIN 9: Calcasieu/Sabine Hydrologic Restoration New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | 9 Marsh Management New Work Active | Passive | Rehab Active | Passive | NW+RE Active | Passive | Marsh Type Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 |
| I | | | 0 | 0 | 0 | 0 | 0 | | 795 | 0 | 0 | 0 | 795 |
| F/I | 27453<br>621<br>3300<br>4090 | 0 | 0 | 0 | 650 | 0 | 0 | 4200 | 0 | 0 | 0 | 0 | 40314 |
| F/I/B | 4600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4600 |
| I/B | 5610 | 30585<br>4422<br>1680<br>30585<br>3500<br>9667<br>23100<br>1700 | 0 | 0 | 2000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 112849 |
| B | 6225 | 7560<br>14500<br>6300<br>2500<br>600 | 0 | 0 | | 0 | 2800 | | 0 | 0 | 1462 | 0 | 48315 |
| | | 6368 | | | | | | | | | | | |
| Sub-totals | | | | | | | | | | | | | Sub-totals |
| Active | 51899 | | 0 | | 2650 | | 2800 | | 795 | | 1462 | | 59606 |
| Passive | | 143067 | | 0 | | 0 | | 4200 | | 0 | | 0 | 147267 |
| New | 194966 | | | | | | 7000 | | | | | | 201966 |
| Rehab | | | 0 | | | | | | 795 | | | | 795 |
| N & R | | | | | 2650 | | | | | | 1462 | | 4112 |
| HR | 197616 | | | | | | | | | | | | 197616 |
| MM | | | | | | | 9257 | | | | | | 9257 |
| Basin Total | 206873 | | | | | | | | | | | | |

Table 5-14: CWPPRA- Basin by Management Alternative

| | Basin 1 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Delta | Chenier | Coastwide | Avg |
|---|---|---|---|---|---|---|---|---|---|---|
| Mgt Type | | | | | | | | | | |
| MM | 8000 | 2548 | 5000 | | 7300 | 4200 | 77614 | 13757 | 91371 | 6527 |
| | | | 2400 | | | 795 | | | | |
| | | | 35857 | | | 1462 | | | | |
| | | | 5407 | | | | | | | |
| | | | 5888 | | | | | | | |
| | | | 8106 | | | | | | | |
| | | | 750 | | | | | | | |
| | | | 3658 | | | | | | | |
| HR | 5924 | 6450 | 4558 | 30000 | | 650 | 190788 | 200416 | 391204 | 8323 |
| | 3915 | 3994 | 7200 | 2181 | | 27453 | | | | |
| | 1289 | 38887 | 15587 | 6697 | | 4090 | | | | |
| | | 3300 | 3000 | 400 | | 621 | | | 482575 | |
| | | | 1600 | | | 3300 | | | | |
| | | | 2248 | | | 3500 | | | | |
| | | | 6090 | | | 4422 | | | | |
| | | | 18206 | | | 9667 | | | | |
| | | | 7222 | | | 1700 | | | | |
| | | | 12266 | | | 1680 | | | | |
| | | | 4544 | | | 23100 | | | | |
| | | | 5230 | | | 5610 | | | | |
| | | | | | | 2000 | | | | |
| | | | | | | 30585 | | | | |
| | | | | | | 30585 | | | | |
| | | | | | | 2800 | | | | |
| | | | | | | 4600 | | | | |
| | | | | | | 7560 | | | | |
| | | | | | | 6368 | | | | |
| | | | | | | 14500 | | | | |
| | | | | | | 6300 | | | | |
| | | | | | | 2500 | | | | |
| | | | | | | 6225 | | | | |
| | | | | | | 600 | | | | |
| Basin MM Tots | 8000 | 2548 | 67066 | 0 | 7300 | 6457 | | | | |
| Basin HR Tots | 11128 | 52631 | 87751 | 39278 | 0 | 200416 | | | | |
| Delta MM Tots | 77614 | Chenier MM Tots | 13757 | MM Tots | 91371 | | | | | |
| Delta HR Tots | 190788 | Chenier HR Tots | 200416 | HR Tots | 391204 | | | | | |
| Coast Totals | 482575 | | | | | | | | | |

Table 5-15: CWPPRA - Region by Management Alternative: Comparison of Total Acres

| | Basin 1 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Delta | Chenier | Coastwide |
|---|---|---|---|---|---|---|---|---|---|
| MM | 8000 | 2548 | 67066 | | 7300 | 6457 | 77614 | 13757 | 91371 |
| HR | 11128 | 52631 | 87751 | 39278 | | 200416 | 190788 | 200416 | 391204 |
| Totals | 19128 | 55179 | 154817 | 39278 | 7300 | 206873 | 268402 | 214173 | 482575 |

Table 5-16: CWPPRA- Comparison of Averages for Management Alternatives

| | Basin 1 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Delta | Chenier | Coastwide |
|---|---|---|---|---|---|---|---|---|---|
| MM | 8000 | 2548 | 8383 | | 7300 | 2152 | 7761 | 3439 | 6527 |
| HR | 3709 | 13158 | 7313 | 9820 | | 8351 | 8295 | 8351 | 8323 |
| Totals | 4782 | 11036 | 7741 | 9820 | 7300 | 7662 | 8133 | 7649 | 7911 |

Table 5-17: CWPPRA- Basin by Included Marsh Type

| Marsh Type | Basin 1 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Basin 1 Avg | Basin 4 Avg | Basin 5 Avg | Basin 7 Avg | Basin 8 Avg | Basin 9 Avg | Delta Totals | Chenier Totals | Coast Totals | Delta Avgs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | | 6450 | | 30000 | | | | 6450 | | 30000 | | | 36450 | | 36450 | 18225 |
| F/I | 5924 | | 5000 | | | 650 | 5924 | 3994 | 3700 | | 7300 | 6719 | 17318 | 47614 | 64932 | 4330 |
| | | 3994 | 2400 | | | 27453 | | | | | | | | | | |
| | | | | | 7300 | 4090 | | | | | | | | | | |
| | | | | | | 4200 | | | | | | | | | | |
| | | | | | | 621 | | | | | | | | | | |
| | | | | | | 3300 | | | | | | | | | | |
| I | 8000 | | | | | | 8000 | | | | | 795 | 8000 | 795 | 8795 | 8000 |
| | | | | | | 795 | | | | | | | | | | |
| F/I/B | | | 7200 | | | 4600 | | | 21528.5 | | | 4600 | 43057 | 4600 | 47657 | 21529 |
| | | | 35857 | | | | | | | | | | | | | |
| I/B | | | 4558 | | | | | | 4558 | | | 10104.45 | 4558 | 111149 | 115707 | 4558 |
| | | | | | | 3500 | | | | | | | | | | |
| | | | | | | 4422 | | | | | | | | | | |
| | | | | | | 9667 | | | | | | | | | | |
| | | | | | | 1680 | | | | | | | | | | |
| | | | | | | 23100 | | | | | | | | | | |
| | | | | | | 5610 | | | | | | | | | | |
| | | | | | | 2000 | | | | | | | | | | |
| | | | | | | 30585 | | | | | | | | | | |
| | | | | | | 30585 | | | | | | | | | | |
| B | 3915 | 38887 | 15587 | 2181 | | 1700 | 2602 | 14912 | 6653 | 3093 | 0 | 6252 | 159019 | 50015 | 209034 | |
| | 0 | 2548 | 5407 | 6697 | | 1462 | | | | | | | | | | |
| | 1289 | 3300 | 3000 | 400 | | 7560 | | | | | | | | | | |
| | | | 1600 | | | 2800 | | | | | | | | | | |
| | | | 5888 | | | | | | | | | | 268402 | 214173 | 482575 | |
| | | | 2248 | | | 6368 | | | | | | | | | | |
| | | | 6090 | | | | | | | | | | | | | |
| | | | 8106 | | | | | | | | | | | | | |
| | | | 750 | | | 14500 | | | | | | | | | | |
| | | | 18206 | | | 6300 | | | | | | | | | | |
| | | | 7222 | | | | | | | | | | | | | |
| | | | 3658 | | | 2500 | | | | | | | | | | |
| | | | 12266 | | | 6225 | | | | | | | | | | |
| | | | 4544 | | | 600 | | | | | | | | | | |
| | | | 5230 | | | | | | | | | | | | | |
| Basin | 19128 | 55179 | 154817 | 39278 | 7300 | 206873 | Totals | | | | | | | | | |
| | 4782 | 11036 | 7741 | 9820 | 7300 | 7662 | Avg | | | | | | | | | |
| Delta | 268402 | | | | | | | | | | | | | | | |
| Chenier | 214173 | | | | | | | | | | | | | | | |
| Coast | 482575 | | | | | | | | | | | | | | | |

Table 5-18: CWPPRA- Summary of Basins/Regions by Included Marsh Type

| | Basin 1 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Delta Totals | Chenier Totals | Coastwide Totals | Delta Avg | Chenier Avg | Coastwide Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | | 6450 | | 30000 | | | 36450 | | 36450 | 18225 | | 18225 |
| F/I | 5924 | 3994 | 7400 | | 7300 | 40314 | 17318 | 47614 | 64932 | 4330 | 6802 | 5903 |
| I | 8000 | | | | | 795 | 8000 | 795 | 8795 | 8000 | 795 | 4398 |
| F/I/B | | | 43057 | | | 4600 | 43057 | 4600 | 47657 | 21529 | 4600 | 15886 |
| I/B | | | 4558 | | | 111149 | 4558 | 111149 | 115707 | 4558 | 10104 | 9642 |
| B | 5204 | 44735 | 99802 | 9278 | | 50015 | 159019 | 50015 | 209034 | 6914 | 6252 | 6743 |
| Totals | 19128 | 55179 | 154817 | 39278 | 7300 | 206873 | 268402 | 214173 | 482575 | | | 7911 |
| Avg | 4782 | 11036 | 7741 | 9820 | 7300 | 7662 | 8133 | 7649 | 7911 | | | |
| n | 4 | 5 | 20 | 4 | 1 | 27 | 33 | 28 | 61 | | | |

Table 5-19: CWPPRA- Marsh Type by Management Alternative

| Mgt | F | F/I | I | F/I/B | I/B | B | Total | Avg |
|---|---|---|---|---|---|---|---|---|
| MM | | 5000 | 8000 | 35857 | | 2548 | 91371 | 6527 |
| | | 2400 | 795 | | | 5407 | | |
| | | 7300 | | | | 5888 | | |
| | | 4200 | | | | 3658 | | |
| | | | | | | 750 | | |
| | | | | | | 8106 | | |
| | | | | | | 1462 | | |
| HR | 6450 | 5924 | | 7200 | 4558 | 3915 | 391204 | 8323 |
| | 30000 | 3994 | | 4600 | 3500 | 1289 | | |
| | | 650 | | | 4422 | 38887 | | |
| | | 27453 | | | 9667 | 3300 | | |
| | | 4090 | | | 1700 | 15587 | | |
| | | 621 | | | 1680 | 3000 | | |
| | | 3300 | | | 23100 | 1600 | | |
| | | | | | 5610 | 2248 | | |
| | | | | | 2000 | 6090 | | |
| | | | | | 30585 | 18206 | | |
| | | | | | 30585 | 7222 | | |
| | | | | | 2800 | 12266 | | |
| | | | | | | 4544 | | |
| | | | | | | 5230 | | |
| | | | | | | 2181 | | |
| | | | | | | 6697 | | |
| | | | | | | 400 | | |
| | | | | | | 7560 | | |
| | | | | | | 6368 | | |
| | | | | | | 14500 | | |
| | | | | | | 6300 | | |
| | | | | | | 2500 | | |
| | | | | | | 6225 | | |
| | | | | | | 600 | | |
| Marsh Type by | 0 | 18900 | 8795 | 35857 | 0 | 27819 | | |
| MM Avg | 0 | 4725 | 4398 | 35857 | 0 | 3974 | | |
| Marsh Type by | 36450 | 46032 | 0 | 11800 | 120207 | 176715 | | |
| HR Avg | 18225 | 6576 | 0 | 5900 | 10017 | 7363 | | |
| Marsh Type Totals | 36450 | 64932 | 8795 | 47657 | 120207 | 204534 | | |
| Coast Totals | 482575 | | | | | | | |

Table 5-20: Permits & CWPPRA- Comparison of Total Acres

| | 1 | 2 | 4 | 5 | 7 | 8 | 9 | Delta | Chenier | Coast |
|---|---|---|---|---|---|---|---|---|---|---|
| PERMITS | 37490 | 13572 | 235315 | 42148 | 25235 | 46031 | 92480 | 353760 | 138511 | 492271 |
| CWPPRA | 19128 | | 55179 | 154817 | 39278 | 7300 | 206873 | 268402 | 214173 | 482575 |
| SUM | 56618 | 13572 | 290494 | 196965 | 64513 | 53331 | 299353 | 622162 | 352684 | 974846 |

Table 5-21: Permits & CWPPRA- Comparison of Average Project Size

| | Basin 1 | Basin 2 | Basin 4 | Basin 5 | Basin 7 | Basin 8 | Basin 9 | Delta | Chenier | Coastwide |
|---|---|---|---|---|---|---|---|---|---|---|
| PERMITS | 6248 | 3393 | 15688 | 3011 | 2294 | 3069 | 8407 | 7075 | 5327 | 6477 |
| CWPPRA | 4782 | | 11036 | 7741 | 9820 | 7300 | 7662 | 8133 | 7649 | 7911 |

Table 5-22: Permits & CWPPRA- Region by Included Marsh Type

| | Permits | | | CWPPRA | | |
|---|---|---|---|---|---|---|
| | Delta | Chenier | Coastwide | Delta | Chenier | Coastwide |
| F | 27755 | 279 | 28034 | 36450 | | 36450 |
| F/I | 10365 | 27266 | 37631 | 17318 | 47614 | 64932 |
| I | 16756 | 5524 | 22280 | 8000 | 795 | 8795 |
| F/I/B | 168657 | 6296 | 174953 | 43057 | 4600 | 47657 |
| I/B | 35182 | 9935 | 45117 | 4558 | 115649 | 120207 |
| B | 56458 | 15987 | 72445 | 159019 | 45515 | 204534 |
| I/B/S | | 66000 | 66000 | | | |
| B/S | 18303 | 7224 | 25527 | | | |
| S | 13134 | | 13134 | | | |
| U | 7150 | | 7150 | | | |
| Total | 353760 | 138511 | 492271 | 268402 | 214173 | 482575 |

Table 5-23: Permits & CWPPRA- Comparison of Total Acres

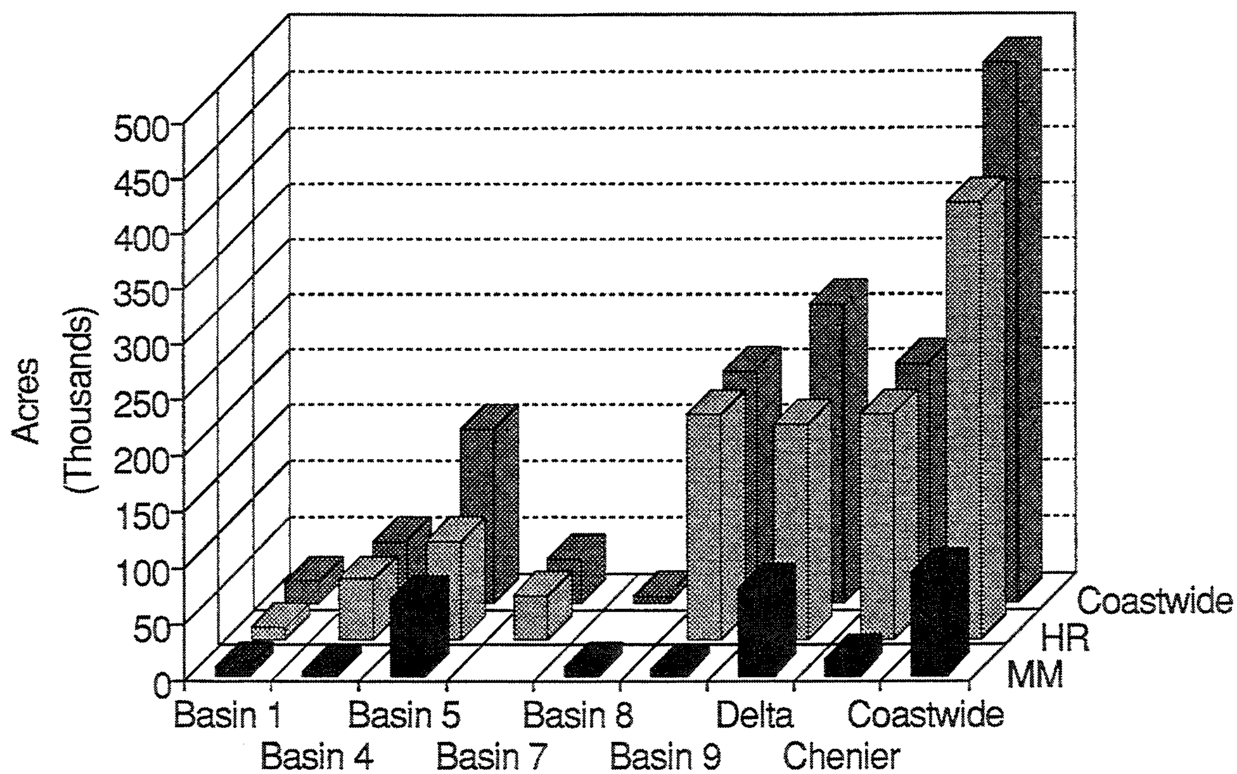
| | F | F/I | I | F/I/B | I/B | B | B/S | I/B/S | S | U | Coast |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PERMITS | 28034 | 37631 | 22280 | 174953 | 45117 | 72445 | 25527 | 66000 | 13134 | 7150 | 492271 |
| CWPPRA | 36450 | 64932 | 8795 | 47657 | 120201 | 204534 | | | | | 482575 |
| SUM | 64484 | 102563 | 31075 | 222610 | 165318 | 276979 | 25527 | 66000 | 13134 | 7150 | 974846 |

Table 5-24: Permits & CWPPRA- Comparison of Average Project Size

| | F | F/I | I | F/I/B | I/B | B | B/S | I/B/S | S | U | Coastwide |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PERMITS | 2803 | 3136 | 4456 | 58318 | 5640 | 2786 | 5105 | 66000 | 13134 | 7150 | 6477 |
| CWPPRA | 18225 | 4330 | 8000 | 21529 | 4558 | 6914 | | | | | 7911 |

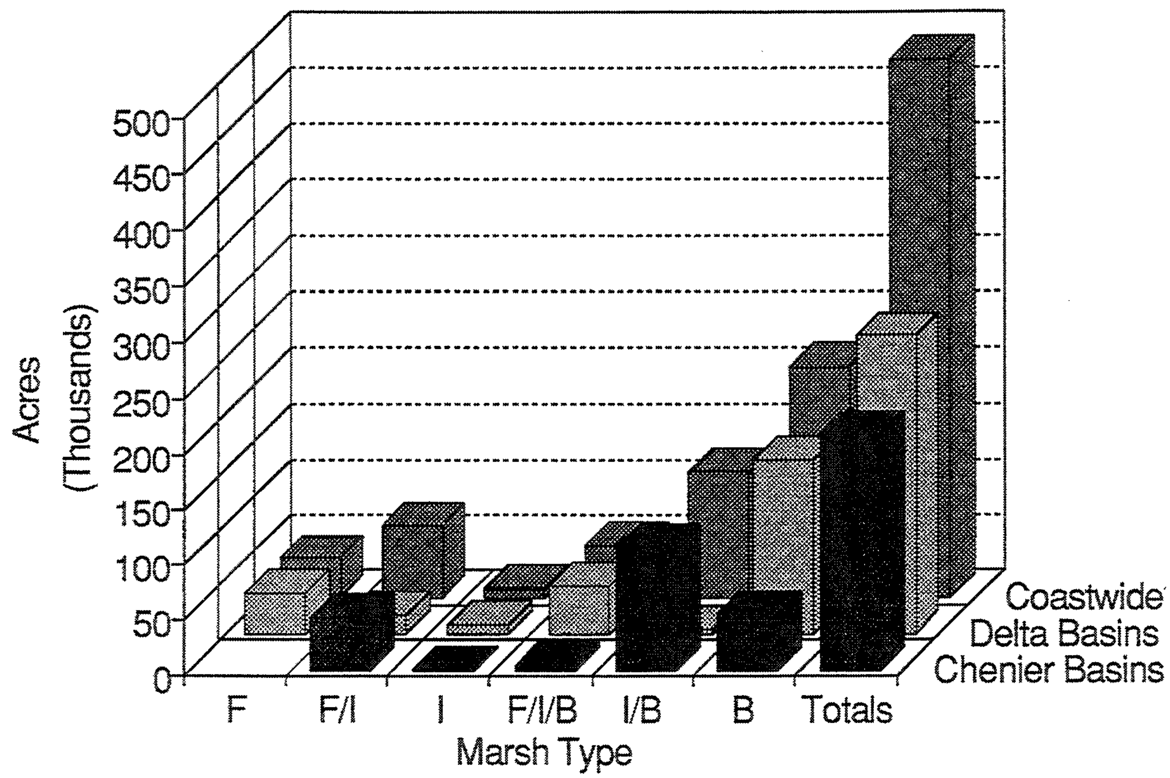
# Figure 17 - CWPPRA: Future

## Region x Management Alternative



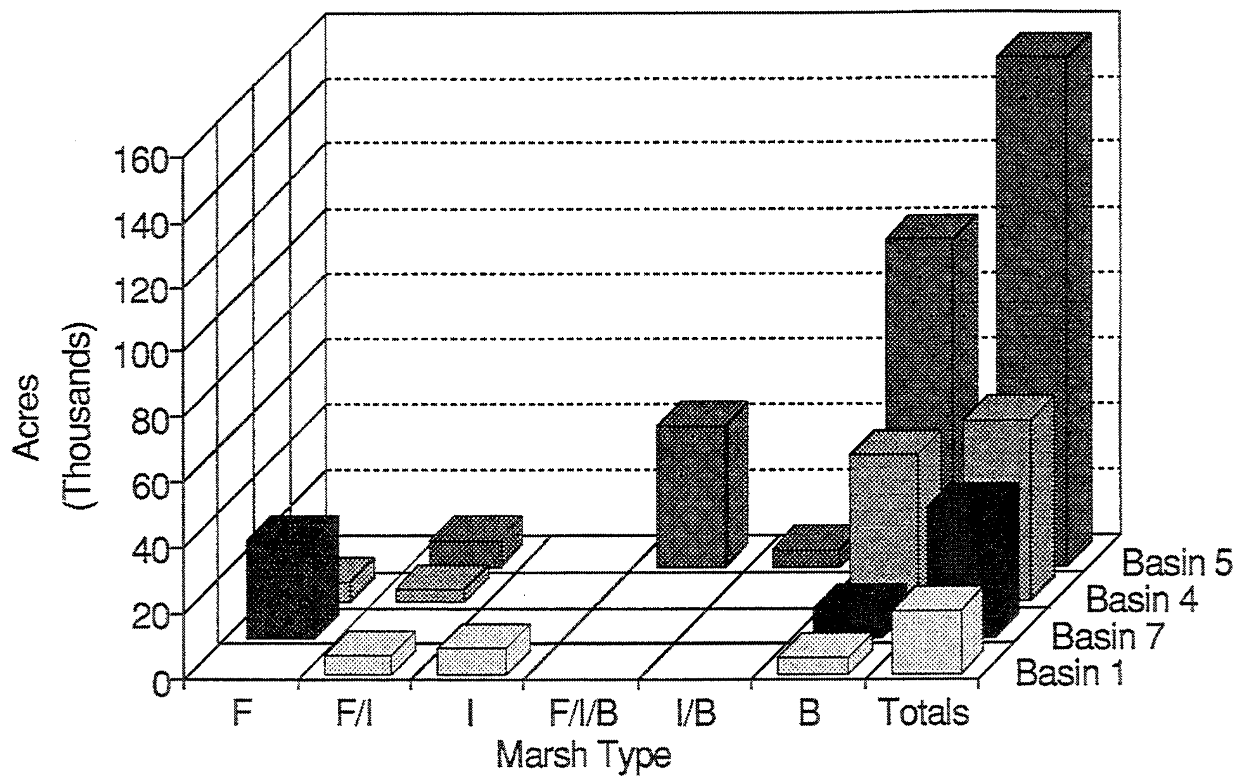
# Figure 18 - CWPPRA: Future

Region x Marsh Type



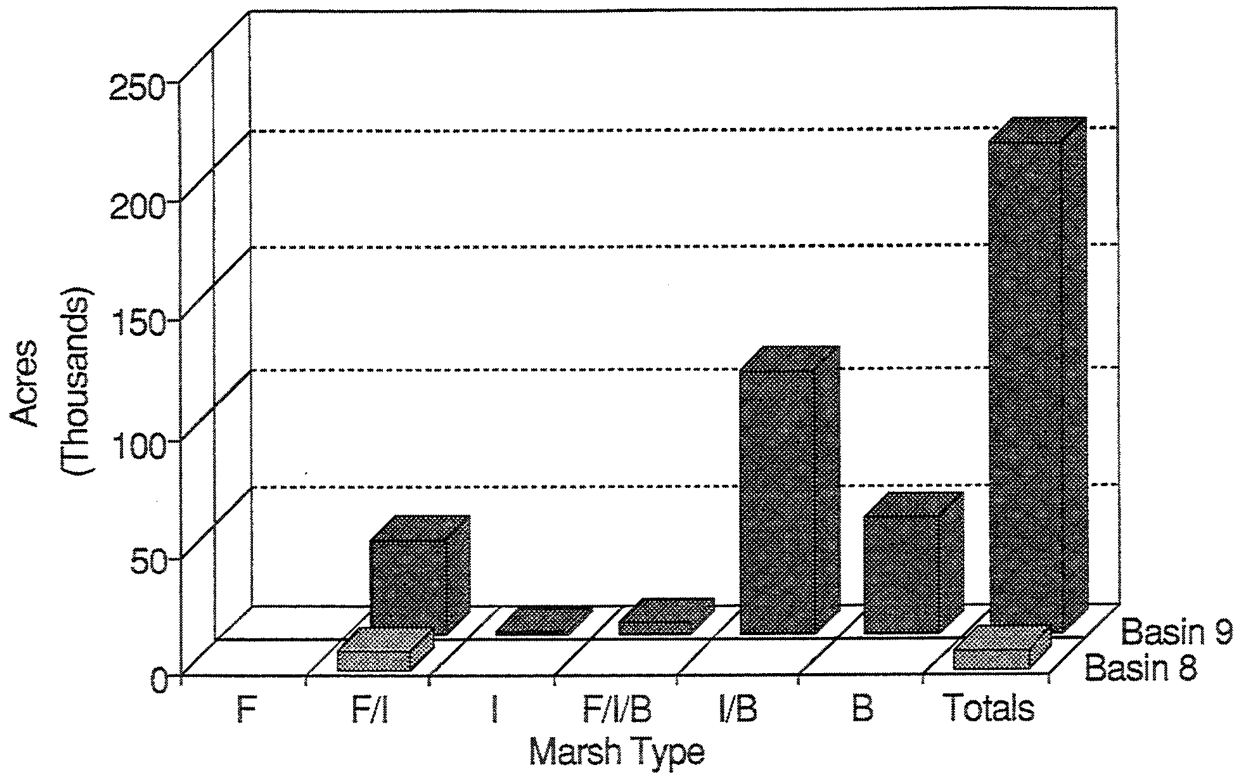
# Figure 19 - CWPPRA: Future

## Delta Basins x Marsh Type



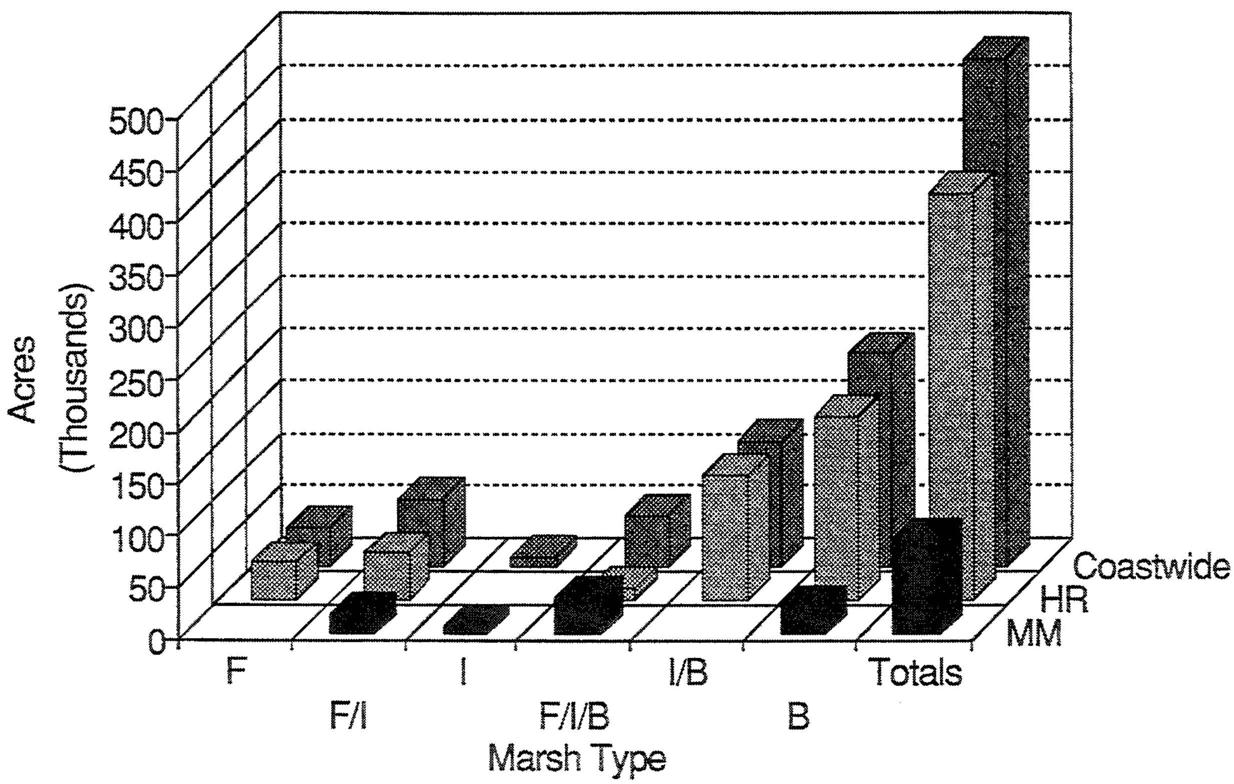
# Figure 20 - CWPPRA: Future

Chenier Basins x Marsh Type



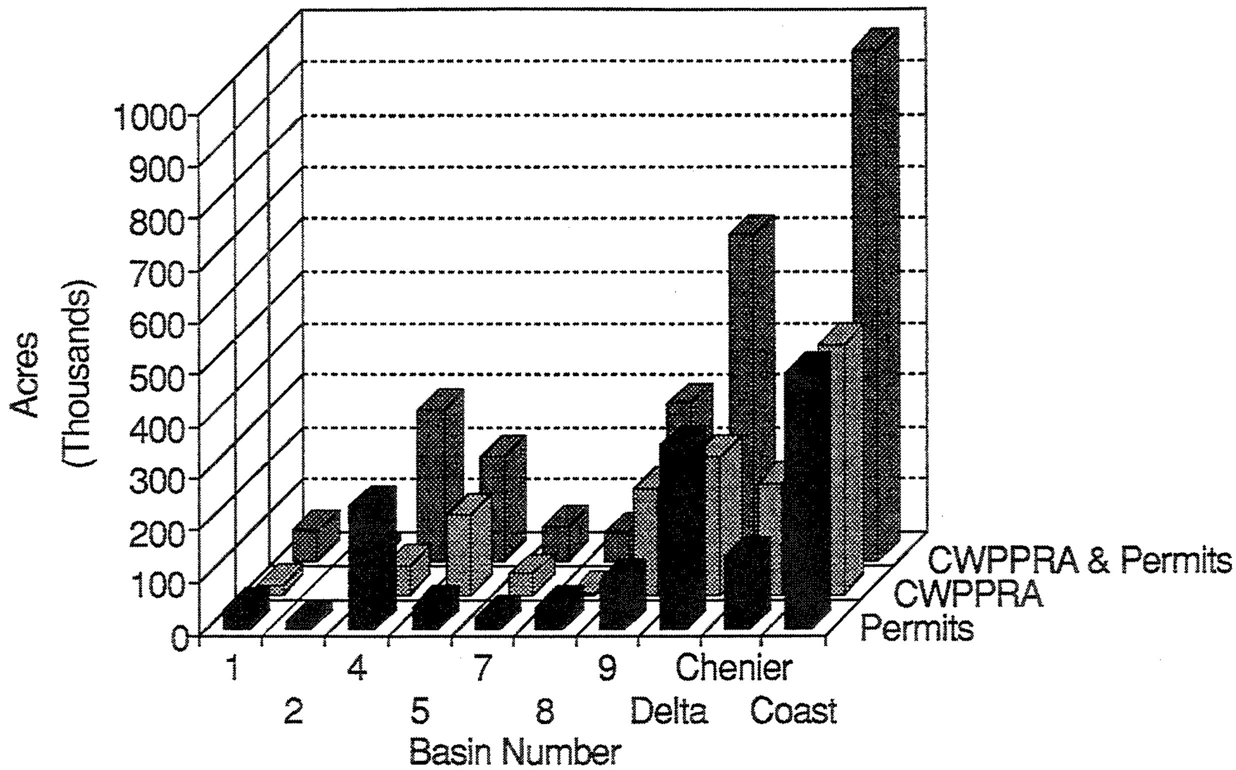
# Figure 21 - CWPPRA: Future

## Management Alternative x Marsh Type



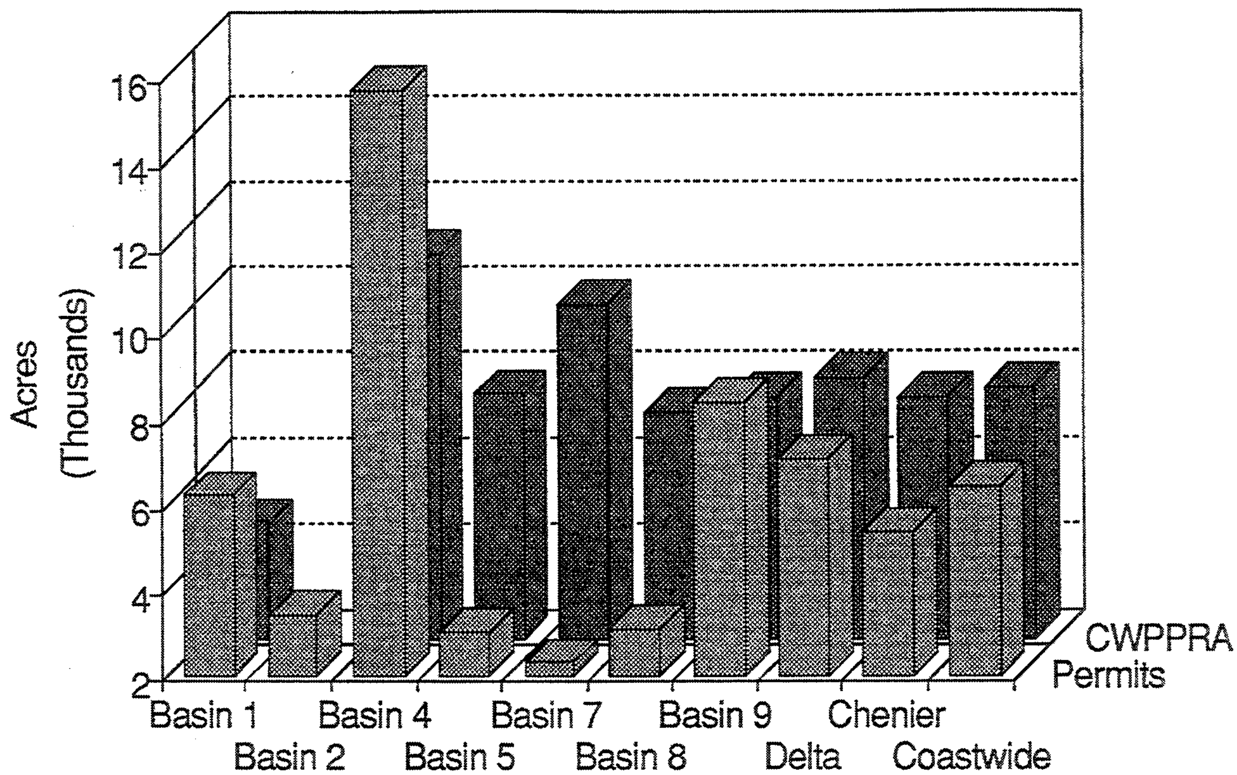
# Figure 22 - PERMITS & CWPPRA

## Comparison of Total Acres



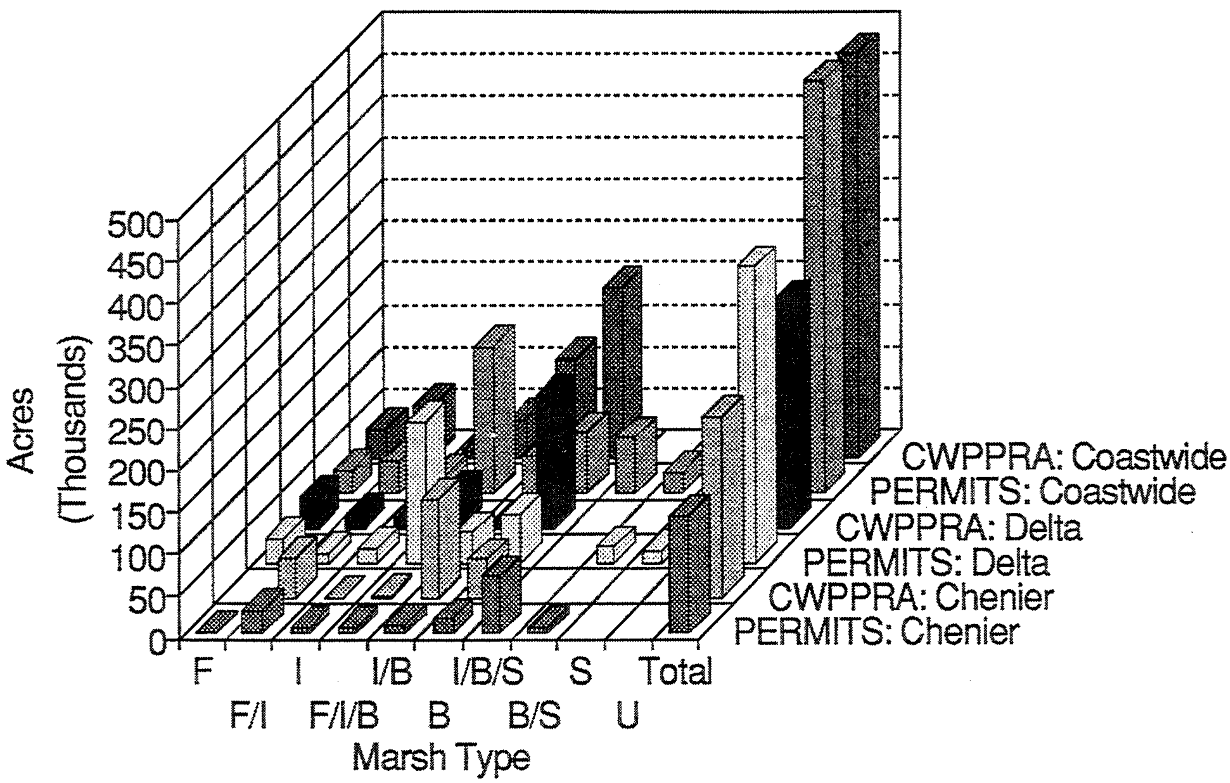
# Figure 23 - PERMITS & CWPPRA

## Comparison of Average Project Size



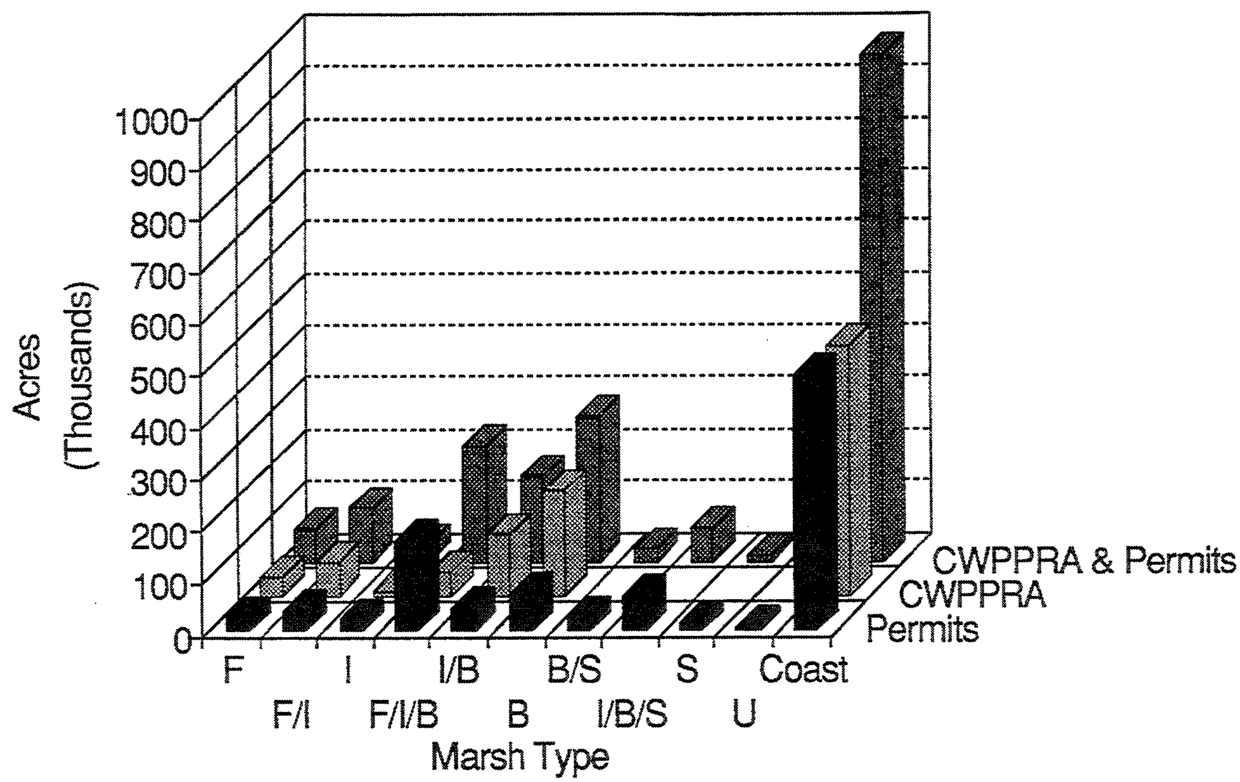
# Figure 24 - PERMITS & CWPPRA

## Region x Marsh Type



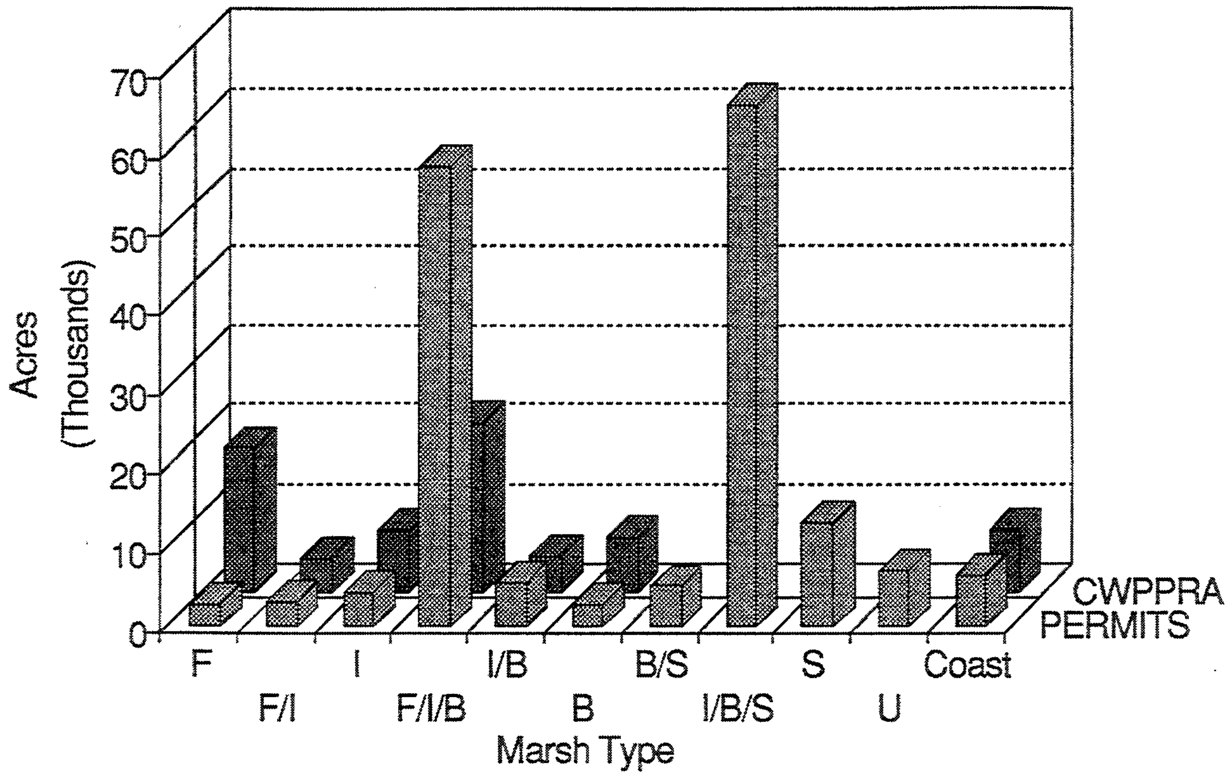
# Figure 25 - PERMITS & CWPPRA

## Comparison of Total Acres



# Figure 26 - PERMITS & CWPPRA

## Comparison of Average Project Size



## 6.0. *COORDINATION/PUBLIC INVOLVEMENT*

### 6.1. **Coordination**

1. December 1986.

Agreement between NOD, NRCS and Louisiana Department of Natural Resources (DNR) on need for marsh management EIS.

2. April 1986.

NOD, NRCS and DNR meet and discuss funding possibilities and work responsibilities preliminary to starting work on the draft programmatic marsh management EIS. NRCS is prepared to assume lead agency status but lacks the funds and man power to begin.

3. November 1987.

NOD, DNR, and NRCS personnel meet again. DNR announces funding agreement with USDI - Minerals Management Service (MMS) to do a study of marsh management as a candidate mitigatory effort for some of MMS's programs. Agreement on the MMS study being a good base from which to write the EIS. NOD declares its intention to assume lead agency status in the EIS process because of its permit involvement but acknowledges the desirability of NRCS participating formally as a cooperating agency.

4. May 1988 - December 1990

NOD participants as member of MMS/DNR marsh management study technical steering committee.

5. Summer 1988

NOD/NRCS attempt to formulate a working agreement for preparing the EIS. Effort deferred until MMS/DNR study completed.

6. July 1991

NOD begins work on EIS. Solicits comments on the MMS study from Federal and state agencies.
6. August 1991
NRCS again invited to participate as cooperating agency.

8. February 1992.

NRCS commits to role as cooperating agency.

9. February-June 1992

NRCS/NOD coordination meetings

10. July-August 1992

EPA, FWS and NMFS accept NOD's invitation to join NOD and NRCS as cooperating agencies.

6.2. **Public Involvement**

1. February 1988.
* The Corps of Engineers, New Orleans District NOD and the USDA - Soil Conservation Service (NRCS) announced their intention to jointly prepare a Draft Programmatic Environmental Impact Statement (DPEIS) for Marsh Management in Coastal Louisiana in the February 10, 1988 edition of the Federal Register (Vol. 53, No. 27, page 3910).

* The NOD AND NRCS announced by public notice and jointly
* sponsored two separate DPEIS public meetings identified as Scoping Workshops: February 23, 1988 - Jennings, Louisiana February 25, 1988 - New Orleans, Louisiana

The purpose of these meetings was to receive public input on marsh management. Written comments were accepted through March 11, 1988.

2. April 1988.

* NOD promulgates the DPEIS scoping document (letter dated April 18, 1988).

6.3. **Coordination With Cooperating Agencies**

* August 1993 - very early version of some draft chapters of PMMDEIS delivered to Coop agencies in advance of coordination meetings

* Sept 1993 - coordination meeting, at which agencies were informed of NOD's funding constraints that necessitated temporarily suspending further work on the PMMEIS

* April 1994 - NOD solicited references from cooperating agencies

* June-August 1994 - NOD merges/tabulates all agency references and prepares its own listing of candidate references and supplies both tabulations to the cooperating agencies

* June 1995 - 50% Review version sent to cooperating ageinces for review and comment.

* July 13, 1995 - coordination meeting to discuss comments on 50 % review version.

6.4. **Coordination With Public**

* June 1994 - Presentation of the PMMEIS concept/status report to the Gulf of Mexico Fishery Management Council

* August 1994 - Status update presented to the EPA Marsh Management Workshop, New Orleans LA

* August 1994 to Present - Respond to several telephone inquiries about status from Tulane Law Clinic and the LSU Sea Grant Program (Legal)

* June 1995 - Presentation of the PMMEIS concept/status report to the Gulf of Mexico Fishery Management Council

* October 1995 - Issuance of Draft PHMEIS

* October - December 1995 - Comments on Draft PHMEIS

## 7.0. *PREPARERS*

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1980 MS- Aquatic Ecology, USL

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* 5 - permitting
* 4 - wetland management proposal review, coordination, research
2 years teaching at USL

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**Robert Lacy**

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2 years US Fish and Wildlife Service (Louisiana)

## US FISH AND WILDLIFE SERVICE (FWS)

**Ronnie Paille**

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Recipient/Commentor 50 % draft document

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Experience: 8 years US Fish & Wildlife Service
* 6 years Ecological Services (Lafayette, LA)
* 2 years Refuge biologist (Sabine Refuge, LA)

4 years biologist Little Pecan Island Management Area

## 8.0. ***LITERATURE CITED and OTHER REFERENCES***

Literature Citations (Candidates) for the Programmatic Marsh Management EIS. Following each citation is a list of the Federal cooperating agencies which submitted the particular reference for inclusion in the PEIS: U.S. Army Corps of Engineers (COE), Environmental Protection Agency (EPA), National Marine Fisheries Service (NMFS), Natural Resource Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS). Literature cited in the text is indicated by a "*".


Allan, P. F. 1950. Ecological bases for land use planning in Gulf Coast marshlands. J. Soil and Water Cons. 5(2):57-62. [NRCS]

Allen, R. L. 1975. Aquatic primary production in various marsh environments in Louisiana. M.S. Thesis, Louisiana State University, Baton Rouge, LA. 50 pp. [NRCS]

Anonymous. Undated. Lafourche Realty Company Estuarine Management Program: 1988 Environmental Monitoring Report. [COE]*

Barlow, J. P. 1956. Effect of wind on salinity distribution in an estuary. J. Mar. Res. 15(3):193-203. [NRCS]*

Barras, J. L., J. B. Johnson and C. Johnson. 1993. Using GIS and image processing technology to assist wetland planning, protection, and restoration in coastal Louisiana. Pages 860-869 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Baumann, R. H. 1980. Mechanisms of maintaining marsh elevation in a subsiding environment. M.S. Thesis, Louisiana State University, Baton Rouge, LA. 90 pp. [EPA]

Baumann, R. H., J. W. Day and C. A. Miller. 1984. Mississippi deltaic wetland survival: sedimentation versus coastal submergence. Science 224:1093-1094. [COE]*

Becker, R. E., W. H. Conner, J. W. Day Jr., W. H. Herke, and R. E. Turner. 1985. The role of science in management of Louisiana wetland impoundments. Abstracts for the 8th Biennial International Estuarine Research Conference. Estuaries 8:59A. [EPA; unable to verify citation]

Blan, K. R. Undated. Nutrients in the Gulf of Mexico. Unpublished manuscript. 10pp. [NRCS]

Bosenberg, R. H. 1979. Rodent populations. Field Data. Pages 9.1-9.23 in T. Sugihara, C. Yearsley, J. Durand and N. Psuty, eds. Comparison of Natural and Altered Estuarine Systems: Analysis, Vol. II. Center for Coastal and Environmental Studies - Rutgers The State University, New Brunswick, New Jersey. [COE]*

Boumans, R. and J. W. Day, Jr. 1990. Short-term sedimentation and water and material fluxes. Pages 384-409 in D. R. Cahoon and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. 3. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]

Boumans, R. M. J., J. W. Day, Jr., and G. P. Kemp. 1993a. Measuring the effect of sediment fences for wetland creation and restoration in Louisiana. Pages 1717-1725 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol. 2. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Boumans, R. M. J., J. W. Day, Jr., and G. P. Kemp. 1993b. Predicting impacts of management measures on fragile coastal wetlands using a predictive landscape model. Pages 694-708 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 2. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Bradshaw, W. H. 1985. Relative abundance of small brown shrimp as influenced by semi-impoundment. M.S. Thesis, Louisiana State University, Baton Rouge, LA. 61 pp. [NMFS]

Breininger, D. R. and R. B. Smith. 1990. Waterbird use of coastal impoundments and management implications in east-central Florida. Wetlands 10(2):223-241. [COE]*

Bricker-Urso, S., S. W. Nixon, J. K. Cochran, D. J. Hirschberg and C. Hunt. 1989. Accretion rates and sedimentation accumulation in Rhode Island salt marshes. Estuaries 12(4):300-317. [COE]

Britsch, L. D., and E. B. Kemp, III. 1990. Land loss rates: Mississippi River deltaic plain. Final Report. U. S. Army, Corps of Engineers - Waterways Experiment Station (Geotechnical Lab). Technical Report GL-90-2 Vicksburg, MS. 25pp, appendix. [COE]*

Broussard, L. Undated. Report on current marsh management engineering practices. USDA - Soil Conservation Service, Alexandria, LA. Partially funded through NOAA Office of Resource Management, Grant No. NA-87AAH-CZ047. [COE]*

Broussard, K. A., M. Lemoine and M. M. Liffmann. 1989. Economic evaluation of coastal recreation projects. Pages 88-99 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Broussard, L. J. and D. M. Grouchy. 1992. The use of structures and other techniques for wetland restoration and protection in coastal Louisiana wetlands. Pages 236-238, in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE, NRCS]

Brown, M. and J. J. Dinsmore. 1986. Implications of marsh size and isolation for marsh bird management. J. Wildl. Manage. 50(3):392-397. [COE]

Brupbacher, R. H., J. E. Sedberry, Jr., and W. H. Willis. 1973. The coastal marshlands of Louisiana - Chemical properties of the soil materials. LSU Bull. 672. 34pp. [NRCS]*

Burbridge, P. R., N. Dankers, and J. R. Clark. 1989. Multiple-use assessment for coastal management. Pages 33-45 in O. T. Magoon, H. Converse, D. Miner, L. T. Tobin and D. Clark, eds. Coastal Zone '89: Proceedings of the Sixth Symposium on Coastal and Ocean Management, Vol. 1. Charleston SC, July 11-14, 1989. [COE]

Burdick, D. M. 1989. Root aerenchyma development in Spartina patens in response to flooding. American Journal of Botany 76(5):777-780. [USFWS]

Burdick, D. M., I. A. Mendelssohn, K. L. McKee. 1989. Live standing crop and metabolism of the marsh grass *Spartina patens* as related to edaphic factors in a brackish, mixed marsh community in Louisiana. Estuaries 12(3):195-204. [COE]*

Buresh, R. J., R. D. Delaune, and W. H. Patrick, Jr. 1980. Nitrogen and phosphorus distribution and utilization by *Spartina alterniflora* in a Louisiana Gulf Coast marsh. Estuaries 3(2):111-121. [COE]

Burleigh, J. G. 1966. The effects of wakefield weirs on the distribution of fishes in a Louisiana saltwater marsh. M. S. Thesis, Louisiana State University, Baton Rouge, LA. 69pp. [NMFS]

Cahoon, D. R. 1994. Recent accretion in two managed marsh impoundments in coastal Louisiana. Ecological Applications 4(1):166-176. [COE, NMFS]

Cahoon, D. R. 1993. Recent accretion in a microtidal salt marsh: the relative contribution of organic and inorganic matter. Page 189 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]

Cahoon, D. R. 1991. Management implications of sediment dynamics in delta marshes of Louisiana. Pages 56-61 in Coastal Depositional Systems in the Gulf of Mexico, Quaternary Framework and Environmental Issues. Twelfth Ann. Res. Conf., Gulf Coast Sect., Soc. Econ. Paleontologists and Mineralbiologists Foundation. Houston, TX. [COE] *

Cahoon, D. R. 1990a. Soil accretion in managed and unmanaged marshes. Pages (409-428) in D. R. Cahoon, and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]

Cahoon, D. R. 1990b. Biological consequences of marsh management in coastal Louisiana. Pages 541-550 in D. R. Cahoon, and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]*

Cahoon, D. R. 1990c. Suitability of marsh management. Pages 551-556 in D. R. Cahoon and C. E. Groat eds. A Study of Marsh Management Practice in Louisiana, Vol. III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]*

Cahoon, D. and J. W. Day, Jr. 1991. Marsh management in Barataria-Terrebonne estuary: Influences on estuarine processes. Pages 121-138 in Barataria-Terrebonne National Estuary Program. Scientific-Technical Committee Data Inventory Workshop Proceedings. Nichols State University, Thibodeaux, LA. [COE]*

Cahoon, D. R. and C. G. Groat. 1990a. Introduction to the study. Pages 3-11 in D. R. Cahoon, and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. II. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075 [COE]*

Cahoon, D. R., and C. G. Groat, eds. 1990b. A study of marsh management practice in coastal Louisiana, Volumes I-IV. Final report submitted to Mineral Management Service, New Orleans, LA. Contract No. 14-12-0001-30410. OCS Study/MMS 90-0075. [NMFS, USFWS]*

Callaway, J. C., R. D. Delaune and W. H. Patrick, Jr. 1992. Accretionary processes along the Gulf Coast: A comparison of rates from coastal wetlands in Louisiana, Mississippi, and Florida, wetlands. Pages 377-381 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Carney, D. F. and R. H. Chabreck. 1977. Spring drawdown as a waterfowl management practice in floating fresh marsh. Proc. Annual Conf. Southeast. Assoc. Fish and Wildlife Agencies 31:266-271. [COE, NRCS]*

Chabreck, R. H. 1994. Marsh management in Louisiana for production of emergent and aquatic plants. Prepared for Louisiana Landowners Assoc., Inc. PO Box 44124, Baton Rouge, LA 70804. 71pp. [COE]*

Chabreck, R. H. 1989. Creation, restoration and enhancement of marshes of Northcentral Gulf Coast marshes. Pages 127-143 in J. A. Kasler and M. E. Kentula, eds. Wetland creation and restoration: The status of the science. Volume I: Regional reviews. EPA/600/3-89/038a. Environmental Research Laboratory, Corvallis, Oregon. [NRCS]

Chabreck, R. H. 1976. Management of wetlands for wildlife habitat improvement in estuarine processes. Pages 226-233 in M. Wiley, ed. Uses, stresses and adaptation to the estuary, Vol 1. Academic Press. New York [NRCS]*

Chabreck, R. H. (Ed). 1973a. Proceedings of the Coastal Management and Estuary Management Symposium. Div of Continuing Education, LSU, Baton Rouge, LA*

Chabreck, R. H. (Ed). 1973b. Proceedings Second Symposium: Coastal marsh and estuary management. Held at Louisiana State University, Baton Rouge, LA. July 17-18, 1972. Published by the Louisiana State University, Division of Continuing Education. 316pp [COE]

Chabreck, R. H. 1972. Vegetation, water and soil characteristics of the Louisiana coastal region. Louisiana State University and Agricultural and Mechanical College. Agri. Exp. Stat. Bull No. 664. 72pp. [COE]*

Chabreck, R. H. 1971. Ponds and lakes of the Louisiana coastal marshes and their value to fish and wildlife. Proc. Ann. Conf. Southeast. Assoc. Game & Fish Comm. p206-215. [NRCS; unable to verify citation]*

Chabreck, R. H. 1970. Marsh zones and vegetative types of the Louisiana coastal marshes. Ph. D. Dissertation. Louisiana State University, Baton Rouge, LA [COE]

Chabreck, R. H. 1968. Weirs, plugs and artificial potholes for the management of wildlife in coastal marshes. Pages 178-192 in J. D. Newsom, ed. Proceedings of the First Coastal Marsh and Estuary Management Symposium. Louisiana State University, Division of Continuing Education, Baton Rouge, LA [EPA, NRCS]*

Chabreck, R. H. 1960. Coastal marsh impoundments for ducks in Louisiana. Proc. Ann. Conf. Southeast. Assoc. Game Fish Comm. 14:24-29. [NRCS]*

Chabreck, R. H., R. J. Hoar, and W. D. Larrick, Jr. 1978. Soil and water characteristics of coastal marshes influenced by weirs. Pages 129-146 in J. W. Day, Jr., ed. Proceedings of the Third Coastal Marsh and Estuary Management Symposium. Louisiana State University, Div. Contin. Educ. Baton Rouge, LA. [EPA, NRCS]*

Chabreck, R. H. and C. M. Hoffpauer. 1962. The use of weirs in coastal marsh management in Louisiana. Proc. Annu. Conf. Southeastern Game and Fish Comm. 16:103-112. [EPA, NRCS]*

Chabreck, R. H., T. Joanen, and S. L. Paulus. 1989. Southern coastal marshes and lakes. Pages 249-277 in L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds. Habitat management for migrating and wintering waterfowl in North America. Texas Tech Univ. Press, Lubbock, TX [EPA]*

Chabreck, R. H., and R. G. Linscombe. 1982. Changes in vegetative types in Louisiana coastal marshes over a 10-year period. Proc. Louisiana Academy of Sciences 1982:98-102. [EPA, NRCS]*

Chabreck, R. H. and J. A. Nyman. 1989. The effects of weirs on plants and wildlife in the coastal marshes of Louisiana. Pages 142-150 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Chabreck, R. H., J. A. Vaughn, M. W. Olinde, and D. F. Carney. 1985. Vegetational characteristics and duck food availability and use in a Louisiana fresh marsh. Pages 17-25 in C. F. Bryan, P. J. Zwank, and R. H. Chabreck, eds. Proceedings of the Fourth Coastal Marsh and Estuary Management Symposium. Baton Rouge, LA [NRCS]*

Chabreck, R. H., R. K. Yancey, and L. McNease. 1974. Duck usage of management units in the Louisiana coastal marsh. Proc. Annual Conf. Southeast. Assoc. Game and Fish Comm. 28:507-516. [EPA]*

Chamberlain, J. L. 1959. Gulf Coast marsh vegetation as food for wintering waterfowl. J. Wildl. Manage. 23(1):97-102. [NRCS]*

Childers, D. L. and J. W. Day, Jr. 1990a. Marsh water column interactions in two Louisiana estuaries. I. Sediment Dynamics. Estuaries 13(4):393-403. [COE]*

Childers, D. L. and J. W. Day, Jr. 1990b. Marsh-water column interactions in two Louisiana estuaries. II. Nutrients. Estuaries 13(4):404-417. [COE]

Christian, R. R., K. Bancroft, and W. J. Wiebe. 1978. Resistance of the microbial community within salt marsh soils to selected perturbations. Ecology 59(6):1200-1210. [COE]*

Cichra, C. E. and R. L. Noble. 1980. Summer drawdown as a fisheries management tool in floodwater retarding structures. Ann. Proc. Texas Chap. Amer. Fish. Soc., Vol. 3, 21 pp. [NRCS]

Clark, D. R. 1989a. A review of the Fina LaTerre Management Area, Theriot, Louisiana, with recommendations for management. Louisiana Department of Natural Resource, Coastal Management Division. Baton Rouge, LA. 13pp. [NMFS]*

Clark, D. R. 1989b. Jean LaFitte National Historical Park management plan review and recommendations for management. Louisiana Department of Natural Resources, Coastal Management Division, Baton Rouge, LA. 18pp. [NMFS]*

Clark, D. and B. Lehto. 1991. Wetland management and its role in coastal restoration as it applies to the Louisiana coastal resources and restoration programs. U.S. EPA National Estuary Workshop. Nichols State University, Thibodeaux, Louisiana. [COE]*

Conner, W. H. 1992. Cypress regeneration in coastal Louisiana and the impact of nutria upon seedling survival. Pages 130-131 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Conner, W. H. and J. W. Day, Jr., eds. 1987. Benthic estuarine and marine communities. Pages 68-79 in W. H. Conner and J. W. Day, Jr., eds. The ecology of Barataria Basin, Louisiana: An estuarine profile. Biological Report 85(7.13). National Wetlands Research Center, U. S. Fish and Wildlife Service, U. S. Depart. of the Interior, Washington, DC. [COE]*

Conner, J. V., and F. M. Truesdale. 1972. Ecological implications of a fresh water impoundment in a low-salinity marsh. Proceedings of the Coastal Marsh and Estuary Management Symposium 2:259-276. [NMFS; unable to verify citation]

Coull, B. C. 1986. Chapter 12 A. benthic meiofauna. Pages 239-254 in M. R. DeVoe, and D. S. Baughman eds. South Carolina coastal wetland impoundments: Ecological characterization, management, status and use. Vol. II: Technical synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]*

Cowan, J. H., Jr., R. E. Turner, D. R. Cahoon. 1987. Marsh management plans in practice: Do they work in coastal Louisiana, USA? Environmental Management 12(1):37-53 [EPA]*

Cowan, J. H., Jr., R. E. Turner, and D. R. Cahoon. 1986. Marsh management plans in coastal Louisiana: Do they work? Coastal Ecology Institute, Center for Wetland Resources, Louisiana State University, Baton Rouge, LA Report to Lee Wilson and Associates, Inc., Santa Fe, New Mexico for the U.S. Environmental Protection Agency. 30pp, appendices. [EPA]*

Craft, B. R. and D. Kleinpeter. 1988. Vegetation and salinity changes following the installation of a fixed crest weir at Avery Island, Louisiana (1982-1986). Pages 120-130 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Craft, C. B., E. D. Seneca and S. W. Broome. 1993. Vertical accretion in microtidal regularly and irregularly flooded estuarine marshes. Estuarine Coastal and Shelf Science 37:371-386. [COE]

Dacey, J. W. H. 1984. Water uptake by roots controls water table movement and sediment oxidation in short *Spartina* marsh. Science 224:487-489. [COE]

Davidson, R. B. and R. H. Chabreck. 1989. Recreational use of management units in brackish marsh. Pages 213-221 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Davis, D. W. 1993a. Crevasses on the lower course of the Mississippi River. Pages 360-378 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]*

Davis, D. W. 1993b. People and resources within the Barataria-Terrebonne National Estuary. Pages 678-693 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]*

Davis, D. W. 1992. Land reclamation in coastal Louisiana: From 1718 to the present. Pages 674-678 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Davis, D. W. 1983. Economic and cultural consequences of land loss in Louisiana. Shore & Beach 51(4):30-39. [NRCS]*

Davis, R. A., Jr. 1978. Coastal sedimentary environments. Springer-Verlag. New York. 420pp. [COE]

Day, J. W, Jr. and W. H. Conner. 1990. Water budget analysis. Pages 375-383 in D. R. Cahoon and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]

Day, J. W., Jr., R. Costanza, K. Teague, N. Taylor, C. F. Kemp, R. Day, and R. E. Becker. 1986. Wetland impoundments: A global survey for comparison with the Louisiana coastal zone. Final Report to Geological Survey Division, Louisiana Department of Natural Resources, Baton Rouge, LA 140 pp. [EPA; unable to verify citation]

Day, J. W., Jr., and N. J. Craig. 1982. Comparison of the effectiveness of management options for wetland loss in the coastal zone of Louisiana. Pages 232-239 in D. F. Boesch, ed. Proceedings of the conference on coastal erosion and wetland modification in Louisiana: causes, consequences, and options. U.S. Fish and Wildlife Service, Biological Service Program, Washington, DC, FWS/OBS-82/59. [EPA]

Day, J. W., D. D. Culley, R.E. Turner and A. J. Mumphrey, Jr. 1979. Proceedings Third Symposium Costal Marsh Management. Div Continuing Education, Baton Rouge, LA. 511 ppg. [COE]*

Day, J. W., C. A. S. Hall, W. M. Kemp, and A. Yanez-Arancibia. 1989. Estuarine ecology. John Wiley and Sons. New York. 558pp [COE]

Day, J., W. Smith, P. Wagner and W. Stowe. 1973. Community structure and carbon budget of a salt marsh and shallow bay estuarine system in Louisiana. As cited in J. W. Day, C. A. S. Hall, W. M. Kemp, and A. Yanez-Arancibia. Estuarine ecology. John Wiley & Sons. New York. [COE]

Day, J. W. and P. H. Templet. 1989. Consequences of sea level rise: Implications from the Mississippi delta. Coastal Management 17:241-257. [COE]*

De La Bretonne, L. Jr., and J. W. Avault, Jr. 1972. Movements of brown shrimp, Penaeus aztecus, and white shrimp, Penaeus setiferus, over weirs in marshes of south Louisiana. Proc. Annu. Conf. Southeast Assoc. Game Fish Comm. 25:651-654. [NRCS]

De La Cruz, A. A. 1976a. The role of tidal marshes in the productivity of coastal waters. Assoc. Southeast. Biol. Bull. 20(1):147-156. [NRCS]*

De La Cruz, A. A. 1976b. The functions of coastal wetlands. Assoc. Southeast Biol. Bull. 23(4):179-185. [NRCS]

Dean, R. G. 1978. Effects of vegetation on shoreline erosional processes. Pages 415-426 in Wetland functions and values: The state of our understanding. American Water Resources Association. [NRCS]

DeLany, B. 1988. Cameron-Creole watershed management preliminary report. Pages 311-318 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Delaune, R. D., R. H. Baumann, and J. G. Gosselink. 1983. Relationships among vertical accretion, coastal submergence, and erosion in a Louisiana Gulf coast marsh. J. Sed. Petrol. 53:147-157. [EPA, NRCS]

Delaune, R. D., J. A. Nyman, and W. H. Patrick, Jr. 1991. Sedimentation patterns in rapidly deteriorating Mississippi River Deltaic Plain coastal marshes: Requirement and response to sediment additions. Pages 59-68 in Resource Development of the Lower Mississippi River. American Water Resources Association. [NRCS]

Delaune, R. D., S. R. Pezeshki, and W. H. Patrick, Jr. 1987. Response of coastal plants to increase in submergence and salinity. J. Coastal Research 3(4):535-546. [NRCS]*

Delaune, R. D., C. N. Reddy, and W. H. Patrick, Jr. 1981. Accumulation of plant nutrients and heavy metals through sedimentation processes and accretion in a Louisiana salt marsh. Estuaries 4(4):328-334. [COE]

Dettmer, A. and N. Cave. 1993. Permit enforcement, the achilles heel of coastal protection: Strategies for effective regulation. Pages 3063-3075 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Dingler, J. R. 1993. Short-term water and suspended- sediment fluctuations in a Louisiana marsh. Pages 220-229 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Dunbar, J. B., L. D. Britsch and B. Kemp, III. 1992. Land loss rates: Report 3 - Louisiana coastal plain. U.S. Army, Corps of Engineers - Waterways Experiment Station (Geological Lab). Technical Report GL-90-2. Vicksburg, MS. 25pp, appendix. [COE]*

Dunbar, J. B., L. D. Britsch and B. Kemp III. 1990. Land loss rates: Report 2 - Louisiana chenier plain. U.S. Army, Corps of Engineers - Waterways Experiment Station (Geological Lab). Technical Report GL-90-2. Vicksburg, MS. 21pp, appendix. [COE]*

Dunlap, R. H. and D. E. Porter. 1993. Use of geographic information processing for the identification of "indirect" impacts associated with regulatory permitting programs: For now a conceptual model. Pages 79-93 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Duronslet, M. J., J. M. Lyon, and F. Marullo. 1972. Vertical distribution of postlarval brown, *Penaeus aztecus*, and white, *P. setiferus*, shrimp during immigration through a tidal pass. Transactions of the American Fisheries Society 101(4):748-752. [COE]

Dutton, B. E. and R. D. Thomas. 1990. The vascular flora of three wildlife refuges in Cameron Parish, Louisiana. *Phytologia* 68(5):333-362. [NRCS]

Edwards, E. W., J. McClanahan, L. Bahr and I vanHeerden. 1995. A White Paper- The State of Louisiana's Policy for Coastal Restoration Activities. [COE]

Ensminger, A. B. 1989. Regulatory procedures impact landowners management programs. Pages 107-111 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Ensminger, A. B. 1963. Construction of levees for impoundments in Louisiana marshes. Proc. Ann. Conf. Southeast. Assoc. Game and Fish. Comm. 17:440-446. [NRCS]

Environmental Protection Agency. 1994. Final Announcement: EPA Workshop on structural Marsh Management. [COE]*

Ezernack, Francis J. Undated. Range and wildlife improved: Staggered borrow pits along cattle walkways. Soil Conservationist 21(9):204-207. [NRCS]

Farber, S. 1993. Project priority ranking under CWPPRA. Pages 1843-1857 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Flynn, K. M. and I. A. Mendelssohn. 1991. Vegetational analysis of the Avoca Island marsh management plan in the lower Atchafalaya Basin, Louisiana. Laboratory for Wetland Soils and Sediments, LSU Center for Wetland Resources, Baton Rouge, LA. Prepared for Louisiana Department of Natural Resources Baton Rouge, LA., and U. S. Environmental Protection Agency, Grant No. X-006391-01-1 [COE]

Foote, L. 1995. Presentation to the Gulf of Mexico Fishery Management Council. June 1995, New Orleans, LA. [COE]*

Foote, A. L., V. Beckett and S. J. Williams. 1993. Natural resource problems solving: An interdisciplinary approach to coastal Louisiana. Pages 258-266 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Foote, L. and L. Johnson. 1994. Controlled experiments: NBS/USGS Studies. U. S. EPA Workshop on Structural Marsh Management. New Orleans, LA. August 16-18, 1994. [COE]*

Foote, A. L. and L. A. Johnson. 1992. Plant stand development in Louisiana coastal wetlands: Nutria grazing effects on plant biomass. Pages 265-271 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Fuller, D. A., R. E. Condrey, J. P. Geaghan, and B. B. Barrett. 1990. An analysis of long-term salinity patterns in the Louisiana coastal zone. Northeast Gulf Science 11(1):11-17. [COE]*

Gagliano, S. 1994. An environmental-economic blueprint for restoring the Louisiana Coastal Zone: The State Plan. Report of the Governor's Office of Coastal Activities Science Advisory Board. Coastal Environments, Inc., Baton Rouge, LA. [COE]*

Gagliano, S. W., H. J. and J. L. van Beek. 1970. Hydrologic and Geologic Studies of Coastal Louisiana: Report No. 2-Salinity regimes in Louisiana Estuaries. Prepared for the New Orleans District, Corps of Engineers. [COE]*

Gagliano, S. W., K. J. Meyer-Arendt and K. M. Wicker. 1981. Land loss in the Mississippi River Deltaic Plain. Trans. Gulf Coast Assoc. Geolog. Societies. October 21-23, 1981. Corpus Christie, TX [COE]

Gagliano, S. M. and D. Roberts. 1987. Management of private wetlands in Coastal Louisiana. Prepared for The Louisiana Environmental Professionals Association. Fourth Water Quality & Wetlands Mgt. Conf. New Orleans, LA. 9pp. [NRCS]*

Gagliano, S. M. and K. M. Wicker. 1988. Processes of wetland erosion in the Mississippi River Deltaic Plain. Pages 28-48 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Gallagher, J. L., R. J. Reimold, R. A. Linthurst, and W. J. Pfeiffer. 1980. Aerial production, mortality, and mineral accumulation-export dynamics in *Spartina alterniflora* and *Juncus roemerianus* plant stands in a Georgia salt marsh. Ecology 61(2):303-312. [COE]

Gan, C. E., and E. J. Luzar. 1992. Conjoint analysis of wetland-based recreation activities. Pages 330-333 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp.*

Gaston, G. R. and J. C. Nasci. 1988. Trophic structure of macrobenthic communities in the Calcasieu estuary, Louisiana. Estuaries 11(3):201-211. [COE]*

Gilmore, R. G. 1987. Fish, macrocrustacean and avian population dynamics and cohabitation in tidally influenced impounded subtropical wetlands. Pages 373-394 in Proceedings of a Symposium on Waterfowl and Wetlands Management in the Coastal Zone of the Atlantic Flyway. Wilmington: Delaware Dept. of Nat. Res. and Env. Control, Delaware Coastal Mgt. Program. [NMFS]

Gilmore, R. G., C. J. Donahoe, and D. W. Cooke. 1982. A comparison of the fish populations and habitat in open and closed salt-marsh impoundments in east-central Florida. Northeast Gulf Science 5:25-37. [NMFS]

Gleason, M. I. and J. C. Zieman. 1981. Influence of tidal inundation on internal oxygen supply of *Spartina alterniflora* and *Spartina patens*. Estuarine, Coastal and Shelf Science 13:47-57. [COE]*

Good, B. and D. Clark. 1993. Louisiana Department of Natural Resources position paper concerning wetland management and hydraulic restoration. Louisiana Department of Natural Resources, Office of Coastal Restoration and Management. Baton Rouge, LA 16 pp. [NRCS]*

Good, B. Clark, D. and D. Soilaeu. 1993. Louisiana Department of Natural Resources Position Paper Concerning Wetland Management and Hydrologic Restoration

Good, B. 1992. Managing coastal Louisiana's renewable base. Pages 140-148 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]

Good, R. E., N. F. Good and B. R. Frasco. 1982. A review of primary production and decomposition dynamics of the belowground marsh component. Pages 139-157 in V. S. Kennedy, ed. Estuarine comparisons. Academic Press. New York [COE]

Gosselink, J. G. 1984. The ecology of delta marshes of coastal Louisiana: A community profile. U.S. Fish and Wildl. Serv. FWS/OBS-84/09. 134pp. [COE]*

Gosselink, J. G., C. L. Cordes and J. W. Parsons. 1979. An ecological characterization study of the chenier plain coastal ecosystem of Louisiana and Texas, 3 Vols. U. S. Fish and Wildlife Service, Office of Biological Services. FWS/OBS-78/9 through 78/11. [COE]*

Gould, H. R. and E. McFarlan, Jr. 1959. Geologic history of the Chenier Plain, southwestern Louisiana. Trans. Gulf Coast Association of Geological Societies 9:261-270. [NRCS]

Governor's Coastal Restoration Technical Committee Report. 1988. Report on measures to maintain, enhance, restore and create vegetated wetlands in coastal Louisiana. Report of the Coastal Restoration Technical Committee, August 17, 1988. 39pp. [NRCS]*

Gross, M. F., M. A. Hardisky, P. L. Wolf and V. Klemas. 1991. Relationship between aboveground and belowground biomass of *Spartina alterniflora* (smooth cordgrass). Estuaries 14(2):180-191. [COE]

Gunter, G. 1938. Notes on invasion of fresh water by fishes of the Gulf of Mexico, with special reference to the Mississippi-Atchafalaya river system. Copeia 2:69-72. [NRCS]

Gunter, G. and W. E. Shell, Jr. 1958. A study of an estuarine area with water-level control in a Louisiana marsh. Proceedings Louisiana Academy of Sciences XXI:5-34. [NRCS]

Hackney, C. T, and A. A. De La Cruz. 1980. In Situ decomposition of roots and rhizomes of two tidal plants. Ecology 61(2):226-231. [COE]

Hanson, H., N. C. Kraus, and L. D. Nakashima. 1989. Shoreline change behind transmissive detached barriers. Pages 568-582 in O. T. Magoon, H. Converse, D. Miner, L. T. Tobin and D. Clark, eds. Coastal Zone '89: Proceedings of the Sixth Symposium on Coastal and Ocean Management, Vol. 1. Charleston SC, July 11-14, 1989. [COE, NRCS]*

Harrington, R. W., Jr. and E. S. Harrington. 1982. Effects on fishes and their forage organisms of impounding a Florida salt marsh to prevent breeding by salt marsh mosquitoes. Bull. of Marine Science 32:523-531. [NMFS]

Hatton, R. S., R. D. Delaune, and W. H. Patrick, Jr. 1983. Sedimentation, accretion, and subsidence in marshes of Barataria Basin, Louisiana. Limn. & Oceanog. 28(3):494-502. [COE]

Herke, W. H. 1991. Can mariculture harm the goose that lays golden eggs? Paper presented January 8, 1991 at the Mariculture Forum '91, Nicholls State University, Thibodeaux, Louisiana. [COE]

Herke, W. H. 1979. Some effects of semi-impoundment on coastal Louisiana fish and crustacean nursery usage. Pages 325-346 in J. W. Day, Jr., D. D. Culley, Jr., R. E. Turner, and A. J. Mumpherey, Jr., eds. Proceedings of the Third Coastal Marsh and Estuary Management Symposium. Louisiana State University, Division of Continuing Education. Baton Rouge, LA. [EPA]*

Herke, W. H. 1971. Use of natural and semi-impounded Louisiana tidal marshes as nurseries for fishes and crustaceans. Ph.D Dissertation, Louisiana State University, Baton Rouge, LA [NMFS, NRCS]*

Herke, W. H. 1967. Weirs, potholes and fishery management. Pages 193-211 in J. D. Newsom, ed. Proceedings of the marsh and estuary management symposium. Louisiana State University, Baton Rouge, LA, July 19-20, 1967. 252pp [NMFS]*

Herke, W. H., E. E. Knudsen, P. A. Knudsen, and B. D. Rogers. 1987a. Effects of semi-impoundment on fish and crustacean nursery use: Evaluation of a "solution." Pages 2562-2576 in O. T. Mogoon, H. Converse, D. Miner, L. T. Tobin, D. Clark, and G. Domurat, eds. Coastal Zone '87: Proceedings of the fifth symposium on coastal and ocean management. American Society of Civil Engineers, New York. [EPA, NMFS]

Herke, W. H. and B. D. Rogers. 1989. Threats to coastal fisheries. Pages 196-212 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NMFS]

Herke, W. H., W. W. Wengert, Jr., and M. E. LaGory. 1987. Abundance of young brown shrimp in natural and semi-impounded marsh nursery areas: Relation to temperature and salinity. Northeast Gulf Science 9(1):9-28. [NMFS]

Herke, W. H., E. E. Knudsen, P. A. Knudsen, and B. D. Rogers. 1992. Effects of semi-impoundment of Louisiana marsh on fish and crustacean nursery use and export. North American Journal of Fisheries Management 12:151-160. [COE, NMFS]

Hess, T. J., Jr, R. H. Chabreck, and T. Joanen. 1975. The establishment and management of Scirpus olneyi under controlled water levels and salinities. Proc. Southeastern Assoc. Game and Fish Commissioners Conf. 29:548-554. [EPA, NRCS]

Hess, T. J. Jr., R. F. Paille, R. J. Moertle, and K. P. Guidry. 1989. Results of an intensive marsh management program at Little Pecan Wildlife Management Area. Pages 278-310 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [EPA, NRCS, USFWS]

Hill, P. L. and C. H. Hershner. 1993. Effects of sea level rise on tidal wetlands: Management implications. Pages 529-537. in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]

Hoar, R. J. 1975. The influence of weirs on soil and water characteristics in the coastal marshlands of southeastern Louisiana. M.S. Thesis, Louisiana State University, Baton Rouge, LA. 94pp. [COE]

Hoese, H. D. 1967. Effect of higher than normal salinities on salt marshes. Contr. Mar. Sci. 12:249-261. [NRCS]

Hoese, H. D. and M. Konikoff. (1995, in press [galley proof]). Effects of marsh management on fisheries organisms: The compensatory adjustment hypothesis. Estuaries 18(1):180-197. [NRCS]*

Hoese, H. D. and M. A. Konikoff. 1990a. Cameron-Creole watershed management fisheries study. Final Report, SFP No. 21913-89-16. La. Dept. Nat. Res., Coastal Mgt. Div., Baton Rouge, LA. [NMFS, NRCS]*

Hoese, H. D. and M. A. Konikoff. 1990b. Fisheries studies on the state wildlife refuge. Interim Report. Department of Biology, University of Southwestern Louisiana. [COE]*

Hoese, H. D., M. Konikoff, J. Hock, and G. Perry. 1990. Comparison of effects of water control structures on fisheries in the Rockefeller Wildlife Refuge. Prepared for Coastal Management Division, Louisiana Department of Natural Resources, Baton Rouge, LA. SFP NO. 21913-89-02. 70 pp. [EPA, NRCS]*

Hsu, Shih-Ang, and B. W. Blanchard. 1993. Meteorological forcing on Louisiana wetlands. Pages 230-242. <u>in</u> O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Jemison, E. S., and R. H. Chabreck. 1962. The availability of waterfowl foods in coastal marsh impoundments in Louisiana. Pages 288-300 <u>in</u> J. B. Trefethen, ed. Transactions of the twenty-seventh North American wildlife natural resources conference. [EPA]*

Joanen, T. and L. L. Glasgow. 1965. Factors influencing the establishment of wigeongrass stands in Louisiana. Proc. Ann. Conf. Southeast. Assoc. Game and Fish Comm. 19:76-92. [NRCS]*

Johnson, L. A., D. A. Reynolds, A. L. Foote. 1993. Production and decomposition of <u>Spartina paten</u> in a degrading coastal marsh. Pages 349-359 <u>in</u> Proceedings, 8th symposium on coastal and ocean management, July 19-23, New Orleans, LA. Vol 1. [USFWS]

Johnston, C. A. 1994. Cumulative impacts to wetlands. Wetlands 14(1):49-55. [COE]

Kadlec, J. A. 1962. Effects of a drawdown on a waterfowl impoundment. Ecology 43(2):267-281. [COE]

Kelley, B. J. and R. D. Porcher. 1986. Chapter 7: Macrophyte productivity. Pages 135-156 in M. R. DeVoe, and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Status and Use. Vol. II: Technical synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC. 611pp [COE]

Kelley, B., H. McKellar and R. Zingmark. 1986. Chapter 10: Summary and comparison of component productivities. Pages 195-199 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC. 611pp [COE]

Klesch, W., D. Davis, R. O'Malley and G. Cleckley. 1993. A National coastal strategy for the future. Pages 737-752 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. Civil Engr., New York, New York. [COE]

Knutson, P. L. 1977. Designing for bank erosion control with vegetation. Pages 716-733 in Coastal Sediments '77. Fifth Symposium of the Waterway, Port, Coastal and Ocean Division of ASCE. November 2-4, 1977. Charleston, SC. American Society of Civil Engineers, New York, New York. [NRCS]

Knudsen, E. E., R. F. Paille, B. D. Rogers, W. H. Herke, and J. P. Geaghan. 1989. Effects of a fixed-crest weir on brown shrimp *Penaeus aztecus* growth, mortality, and emigration in a Louisiana coastal marsh. North American Journal of Fisheries Management 9:411-419. [COE, NMFS]

Koch, M. S. and I. A. Mendelssohn. 1989. Sulphide as a soil phytotoxin: Differential responses in two marsh species. Journal of Ecology 77:565-578. [COE]*

Konikoff, M., and H. D. Hoese. 1989. Marsh management and fisheries on the State Wildlife Refuge--Overview and beginning study of the effect of weirs. Pages 181-195 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS] *

Kosters, E. C., G. L. Chmura, and A. Bailey. 1987. Sedimentary and botanical factors influencing peat accumulation in the Mississippi Delta. Journal of the Geological Society, London, 144:423-434. [USFWS]

Kozlowski, T. T., Ed. 1984. Flooding and Plant Growth. Academinc Press, Inc. Orlando, FL [COE]*

Kuecher, G. J. 1995. Geologic framework and consolidation settlement potential of the Lafourche delta, topstratum valley fill; implication for wetland loss in Terrebonne and Lafourche parishes, Louisiana. Ph.D Dissertation, Louisiana State University, Baton Rouge, LA 345pp [COE]*

Kuecher, G. J., N. Chandra, H. H. Roberts, J. H. Suhayda, S. J. Williams, S. P. Penland, and W. J. Autin. 1993. Consolidation settlement potential in south Louisiana. Pages 1197-1214 <u>in</u> O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. Amer. Soc. of Civil Engineers. New York, New York. [COE]*

Landin, M. C. 1992. The importance of manmade structures and features in the lower Mississippi River and batture to wildlife population dynamics, wetlands. Pages 491-499 <u>in</u> M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE, NRCS]

Larrick, W. D., Jr. and R. H. Chabreck. 1976. Effects of weirs on aquatic vegetation along the Louisiana coast. Proc. Southeast. Assoc. Game & Fish Comm. 30:581-589. [NRCS]*

LaSalle, M. W. and L. P. Rozas. 1991. Comparing benthic macrofaunal assemblages of creekbank beds of the spikerush *Eleocharis parvula* (R&S) Link and adjacent unvegetated areas in a Mississippi brackish marsh. Wetlands 11(2):229-244. [COE]

Latham, P. J., L. G. Pearlstein and W. M. Kitchens. 1991. Spatial distribution of the softstem bulrush, *Scirpus validus*, across a salinity gradient. Estuaries 14(2):192-198. [COE]*

LeBlanc, R. J. 1989. The geological history of the marshes of coastal Louisiana. Pages 1-27 <u>in</u> W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Lehto, B. and J. Murphy. 1988. Effects of drawdown and water management on a seriously eroded Marsh. Pages 164-169 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [NRCS]*

Linde, A. F. 1969. Techniques for wetland management. Wisconsin Department of Natural Resources Research Publ. No. 45. 156pp. [USFWS]*

Linscombe, G. 1993. The dynamics of nutria populations and wetland vegetation. Pages 120-121 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]*

Linthurst, R. A. and E. D. Seneca. 1981. Aeration, nitrogen and salinity as determinants of *Spartina alterniflora* Loisel. growth response. Estuaries 4(1):53-63. [COE]*

Livingston, R. J. 1987. Field sampling in estuaries: The relationship of scale to variability. Estuaries 10(3):194-207. [COE]

Llewellyn, D. W. and G. Shaffer. 1993. Marsh restoration in the presence of intense herbivory: The role of *Justicia lanceolata* (Chapm.) Small. Wetlands 13(3)176-184. [COE]*

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 1993. Louisiana Coastal Wetlands Restoration Plan: Main report and environmental impact statement. Prepared by the Louisiana Coastal Wetlands Conservation and Restoration Task Force. Baton Rouge, LA [COE]*

Lowery, G. H., Jr. 1974. The mammals of Louisiana and its adjacent coastal waters. Louisiana State University Press, Baton Rouge, LA 565pp. [COE]*

Marshall, W. D. and H. N. McKellar. 1986. Aquatic community metabolism and plankton productivity. Chapter 8, pages 157-177 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]*

May, J. P. and P. B. Zielinski. 1986. Chapter 5: Sedimentology, hydrogeology and hydrology. Pages 79-102 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]

McBride, R. A. 1989. Accurate computer modeling of coastal change: Bayou Lafourche shoreline, Louisiana, USA. Pages 707-719 in O. T. Magoon, H. Converse, D. Miner, L. T. Tobin and D. Clark, eds. Coastal Zone '89: Proceedings of the Sixth Symposium on Coastal and Ocean Management, Vol. 1. Charleston SC, July 11-14, 1989. [COE]*

McCaffery, R. J. and J. Thompson. 1980. A record of the accumulation of sediment and trace metals in a Connecticut salt marsh. Advances in Geophysics 22:165-236. [COE]

McGovern, J. C. and C. A. Wenner. 1990. Seasonal recruitment of larval and juvenile fishes into impounded and non-impounded marshes. Wetlands 10(2): 203-221. [NMFS]

McKee, K. L. and E. D. Seneca. 1982. The influence of marsh macrophytes. Estuaries 5(4):302-309. [COE]

McKee, K. L. and W. H. Patrick, Jr. 1988. The relationship of smooth cordgrass (*Spartina alterniflora*) to tidal datums: A review. Estuaries 11(3):143-151. [COE]*

McKee, K. L., I. A. Mendelssohn, E. M. Swenson, F. C. Wang, and W. J. Wiseman, Jr. 1987. Saltwater intrusion working group: consensus report. Pages 181-183 in R. E. Turner, and D.R. Cahoon, eds. Causes of wetland loss in the coastal central Gulf of Mexico. Vol. II: Technical narrative. Final report submitted to Mineral Management Service, New Orleans, LA. Contract No. 14-12-001-30251. OCS Study/MMS 87-0120. Vol II. 400pp. [USFWS]

Meeder, J. F. 1989. Comparisons of salinity, hydrology, and vegetation characteristics between free-flowing and semi-impounded intermediate-to-brackish tidal marsh systems. Pages 131-141 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [USFWS]*

Meeder, J. F. 1987. Variable effects of hurricanes on the coast and adjacent marshes: A problem for marsh managers. Pages 337-374 in N. V. Brodtmann, Jr., ed. Fourth Water Quality and Wetlands Management Conference Proceedings. New Orleans, LA, Sept. 24-25, 1987. [COE]*

Mendelssohn, I. A. and K. L. McKee. 1988. *Spartina alterniflora* die-back in Louisiana: Time-course investigations of soil waterlogging effects. Journal of Ecology 76:509-521. [COE]*

Mendelssohn, I. A., and K. L. McKee. 1987. Experimental field and greenhouse verification of the influence of saltwater intrusion and submergence on marsh deterioration: Mechanisms of action. Pages 145-178 in Turner, R. E., and D. R. Cahoon, eds. Causes of wetland loss in the coastal central Gulf of Mexico. Vol. II: Technical narrative. Final report submitted to Mineral Management Service, New Orleans, LA. Contract No. 14-12-001-30251. OCS Study/MMS 87-0120. 400 pp. [USFWS]*

Mendelssohn, I. A., K. L. McKee, and W. H. Patrick, Jr. 1981. Oxygeny deficiency in *Spartina alterniflora* roots: Metabolic adaptation to anoxia. Science 214:439-441. [COE]*

Michout, T. C. 1995 draft. Marsh loss in coastal Louisian: Implications for mangement of North American Anatidae. US National Biological Survey, Lafayette, LA [COE]*

Miller, S. 1956. Ranching in the Louisiana marshes. Journal of Range Management 9(6):284-285. [NRCS]*

Mitsch, W. J. and J. G. Gosselink. 1993. Wetlands. Van Norstrand Reinhold. New York. 722pp. [COE]*

Montague, C. L., A. V. Zale, and H. Franklin Percival. 1987. Ecological effects of coastal marsh impoundments: A review. Environmental Management 11(6):743-756. [COE, NRCS]*

Moorman, A. M., T. E. Moorman, G. A. Baldassarre, and D. M. Richard. 1991. Effects of saline water on growth and survival of mottled duck ducklings in Louisiana. J. Wildl. Manage. 55(3):471-476. [COE]*

Morton, T. 1973. The ecological effects of water control-structures on an estuarine area, White Lake, Louisiana. M.S. Thesis, University of Southwestern Louisiana, Lafayette, LA. 46 pp. [NMFS]

Murphy, K. 1989. Soils of Louisiana's Coastal Marsh. Pgs 58-74 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U.S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp.*

Murray, S. P., N. D. Walker, and C. E. Adams, Jr. 1993. Impacts of winter storms on sediment transport within the Terrebonne Bay marsh complex. Pages 56-70 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. Amer. Soc. of Civil Engineers. New York, New York. [USFWS]

Murray, S. P. and C. Adams. 1991. Sediment transport in the Terrebonne Bay-marsh complex. GCSSEPM Foundation Twelfth Annual Research Conference, Program and Abstracts, December 5, 1991. [COE]

Myers, L. G., J. L. Miller, and C. H. Tate. 1993. Engineered structures: Successes and failures. Pages 231-238 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]

Newsome, J. D. (Ed). 1967. Proceedings of the First Coastal Marsh and Estuary Management Symposium. Div of Continuing Education, LSU, Baton Rouge, LA. 250 ppg. [COE]*

North American Waterfowl Management Plan, Gulf Coast Joint Venture. 1990. Gulf Coast joint venture plan. 35pp. [COE]*

Nyman, J. A. 1994. When and where is sediment needed in marshes? EPA Workshop on Structural Marsh Management. August, 1994. New Orleans, LA [COE]

Nyman, J. A., J. C. Callaway, and R. D. Delaune. 1993. Case study of a rapidly submerging coastal environment: Relationships among vertical accretion, carbon cycling, and marsh loss in Terrebonne Basin, Louisiana. Pages 452-487 in Proceedings of the Hilton Head Island South Carolina U.S.A., International Coastal Symposium, June 6-9, 1993. Vol. 2. [USFWS]*

Nyman, J. A., M. Carloss, R. D. Delaune, and W. H. Patrick. 1994 Spatial patterns of soil and vegetation characteristics relative to interior breakup of a gulf coast brackish marsh. [EPA - unable to verify citation]

Nyman, J. A., M. Carloss, R. D. Delaune and W. H. Patrick, Jr. 1994. Erosion rather than plant dieback as the mechanism of marsh loss in and estuarine marsh. Earth Surface Processes and Landforms 19:69-84. [COE]*

Nyman, J. A., M. Carloss, R. D. Delaune, and W. H. Patrick, Jr. 1993e. Are landscape patterns related to marsh loss processes? Pages 337-348 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [NRCS, USFWS]*

Nyman, J. A., R. H. Chabreck, R. D. Delaune, and W. H. Patrick, Jr. 1993c. Submergence, salt-water intrusion, and managed Gulf Coast marshes. Pages 1690-1704 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 2. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [USFWS]*

Nyman, J. A., R. H. Chabreck, and N. W. Kinler. 1993a. Some effects of herbivory and 30 years of weir management on emergent vegetation in brackish marsh. Wetlands 13(3):165-175. [COE, NRCS]*

Nyman, J., R. Chabreck, and N. Kinler. 1993e (In press). An evaluation of effects of weir-management on emergent marsh vegetation at Marsh Island, Louisiana. Journal of Applied Ecology. 21pp. [EPA; unable to verify citation]

Nyman, J. A., R. H. Chabreck, and R. G. Linscombe. 1990. Effects of weir management on marsh loss, Marsh Island, Louisiana, USA. Environmental Management 14(6):809-814. [EPA, NMFS, NRCS]*

Nyman, J. A. and R. D. Delaune. 1991. CO2 emission and soil Eh responses to different hydrological conditions in fresh, brackish and saline marsh soils. Limnol. Oceanogr. 36:1406-1414. [NRCS]

Nyman, J. A., and R. D. Delaune. 1990. Wetland soil formation in the rapidly subsiding Mississippi River Deltaic Plain: Mineral and organic matter relationships. Estuarine, Coastal and Shelf Science 31:57-69. [USFWS][NRCS]*

Nyman, J. A., R. D. Delaune, W. H. Patrick, Jr. and N. H. Roberts. 1992. Relationships among vegetation, mineral sediments, and vertical accretion in coastal marshes, wetlands. Pages 166-169 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp.[NRCS]

Nyman, J. A., R. D. Delaune and W. H. Patrick, Jr. 1990. Wetland soil formation in the rapidly subsiding Mississippi River Deltaic Plain: Mineral and organic matter relationships. Estuarine, Coastal and Shelf Science. 31:57-69. [USFWS][NRCS]*

Nyman, J. A., R. D. Delaune, H. H. Roberts, and W. H. Patrick, Jr. 1993f). Relationships between vegetation and soil formation in a rapidly submerging coastal marsh. Mar. Ecol. Prog. Ser. 96:269-279. [NRCS, USFWS]*

O'Connell, M. A. and R. F. Noss. 1992. Private land management for biodiversity conservation. Environ. Manage. 16:435-450. [NRCS]

Odum, W. E., J. C. Zieman, and E. J. Heald. 1972. The importance of vascular plant detritus to estuaries. Pages 91-114 in R. H. Chabreck, ed. Proceedings of the second symposium on coastal marsh and estuary management. Division of Continuing Education, Louisiana State University, Baton Rouge, LA 316pp. [NRCS]

Odum, E. P., J. B. Birch, and J. L. Cooley. 1983. Comparison of giant cutgrass productivity in tidal and impounded marshes with special reference to tidal subsidy and waste assimilation. Estuaries 6(2):88-94. [COE]

Olmi, E. J. 1986. Chapter 13: Recruitment patterns of selected decapod crustaceans. Pages 303-360 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]*

Olsen, R. B. and R. E. Noble. 1976. Spoil bank avifauna in the intermediate marshes of southwestern Louisiana. Proc. Southeast. Assoc. Game & Fish Comm. 30:575-580. [NRCS]

Osborn, T. and R. Ruebsamen. 1993. United States National Marine Fisheries Service role/contribution to implementation of the Coastal Wetlands, Planning, Protection and Restoration Act of 1990. Pages 626-632 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]

Osborn, T., R. Ruebsamen and C. Collison-Kahl. 1993. United States National Marine Fisheries Service Role/Contribution in Restoring Coastal Habitats Under the Coastal Wetlands Planning, Protection and Restoration Act of 1990. Pages 1517-1526 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Paille, R. F., T. J. Hess, Jr., R. J. Moertle, and K. P. Guidry. 1989. A comparison of white shrimp productivity within actively versus passively managed semi-impounded marsh nurseries. Pages 170-180 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U.S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [EPA, NMFS, NRCS]*

Paille, R. and C. Shuck. 1993. Fisheries monitoring on Sabine National Wildlife Refuge and Cameron-Creole marshes, Cameron Parish, Louisiana. Pages 500-520 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]*

Palermo, M. R. 1993. A design sequence for wetlands restoration and establishment projects. Pages 219-223 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]

Palmisano, A. W. 1972. Habitat preference of waterfowl and fur animals in the northern Gulf Coast marshes. Pages 163-190 in R. H. Chabreck, ed. Proceedings of the second symposium on coastal marsh and estuary management. Division of Continuing Education, Louisiana State University, Baton Rouge, LA 316pp. [NRCS]*

Penfound, W. T. and E. S. Hathaway. 1938. Plant communities in the marshlands of southeastern Louisiana. Ecol. Monog. 8:1-56. [COE]*

Penland, S. and K. E. Ramsey. 1990. Relative sea-level rise in Louisiana and the Gulf of Mexico: 1908-1988. J. Coast. Res. 6(2):323-342. [COE]*

Perret, W. S., J. E. Roussel, J. F. Burdon and J. F. Pollard. 1993. Long term trends of some trawl-caught estuarine species in Louisiana. Pages 3459-3473 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Perry, W. G. 1981. Seasonal abundance and distribution of brown and white shrimp in a semi-impounded Louisiana coastal marsh. Proc. Louisiana Academy of Sciences 44:102-111. [EPA]*

Perry, W. G. 1976. Standing crops of fishes of an estuarine area in southwest Louisiana. Proc. 30th Ann. Conf. Southeast. Assoc. Game and Fish Comm. p71-81. [NRCS; unable to verify citation]

Perry, W. G., and T. Joanen. 1986. Seasonal abundance and distribution of marine organisms in a semi-impounded Louisiana wildlife management area. Proc. Louisiana Academy of Sciences 49:34-44. [EPA]*

Peterson, G. W. and R. E. Turner. 1994. The value of salt marsh edge vs interior as a habitat for fish and decapod crustaceans in a Louisiana tidal marsh. Estuaries 17(1B):235-262. [COE]*

Pezeshki, S. R. and R. D. Delaune. 1993. Selection of superior planting stocks and development of regeneration techniques for coastal restoration: A pilot study. Pages 3334-3346 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Pezeshki, S. R., and R. D. Delaune. 1990. Influence of sediment oxidation-reduction potential on root elongation in Spartina patens. Acta Ecologia 11(3): 377-383. [USFWS]*

Pezeshki, S. R., R. D. Delaune, and S. Z. Pan. 1991. Relationship of soil hydrogen sulfide level to net carbon assimilation of Panicum hemitomon and Spartina patens. Vegetatio 95:159-166. [USFWS]*

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987a. Effects of flooding and salinity on photosynthesis of *Sagitarria lancifolia*. Marine Ecol. Prog Ser. 41:87-91. [COE]*

Pezeshki, S. R., R.D. Delaune and W.H. Patrick, Jr. 1987b. Response of freshwater marsh species, Panicum hemitomon Schult., to increased salinity. Freshwater Biology 17:195-200. [NRCS]*

Pezeshki, S. R., R. D. Delaune and W. H. Patrick, Jr. 1987c. Response of Spartina patens to increasing levels of salinity in rapidly subsiding marshes of the Mississippi River Deltaic Plain. Estuarine, Coastal and Shelf Science 24:389-399. [NRCS, USFWS]*

Pezeshki, S. R., R. D. Delaune, W. H. Patrick, Jr., and B. J. Good. 1989. Response of Louisiana Gulf Coast marshes to saltwater intrusion. Pages 75-85 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [COE]*

Pezeshki, S. R., S. W. Matthews, and R. D. Delaune. 1990. Root cortex structure and metabolic responses of Spartina patens to soil redox conditions. Environmental and Experimental Botany 31:91-97. [USFWS]*

Pittman, L. P., and C. Piehler. 1989. Sampling and monitoring marsh management plans in Louisiana. Pages 351-368 in O. T. Magoon, H. Converse, D. Miner, L. T. Tobin, and D. Clark, eds. Coastal Zone '89. Volume 1, Proceedings of the Sixth Symposium on Coastal and Ocean Management. July 11-14, 1989, Charleston, SC. American Society of Civil Engineers. New York, New York [NMFS]*

Platt, S. G., C. G. Brantley, and L. W. Fontenot. 1989. Herpetofauna of the Manchac Wildlife Management Area, St. John The Baptist Parish, Louisiana. Proc Lousiana Acad. Sci. 52:22-28. [COE]*

Rafferty, P. S., T. G. Hargis, J. C. Lynch and R. Twilley. 1993. Redox conditions of two Louisiana coastal watersheds as influenced by vegetation and hydrology. Pages 639-643 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [COE]

Rakocinski, C. F., D. M. Baltz and J. W. Fleeger. 1992. Correspondence between environmental gradients and the community structure of marsh-edge fishes in Louisiana estuary. Mar. Ecol. Prog. Ser. 80:135-148. [COE]*

Reed, D. 1994. Marsh management in coastal Louisiana: Impact on vegetation, accretion and fisheries productivity. A Briefing Document. Unpublished manuscript. [COE]

Reed, D. J. 1992. Effects of weirs on sediment deposition in Louisiana coastal marshes. Environmental Management 16(1):55-65. [NMFS]

Reed, D. 1991. Sediment depositions in Louisiana coastal marshes. GCSSEPM Foundation Twelfth Annual Research Conference. pp. 211-213. [COE]*

Reed, D. 1989a. Modeling sediment delivery to Louisiana coastal salt marshes: Natural processes and options for management. Pages 67-74 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [COE]*

Reed, D. 1989b. Patterns of sediment deposition in subsiding coastal salt marshes, Terrebonne Bay, Louisiana: The role of winter storms. Estuaries 12(4):222-227. [COE]*

Reed, D. J. and D. R. Cahoon. 1993. Marsh submergence vs. marsh accretion: Interpreting accretion deficit data in coastal Louisiana. Pages 243-257 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol. 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Reed, D. J. and D. R. Cahoon. 1992. The relationship between marsh surface topography, hydroperiod, and growth of *Spartina alterniflora* in a deteriorating Louisiana salt marsh. Journal of Coastal Research, 8(1):77-87. [COE]*

Reed, D. J. and B. A. McKee. 1991. Patterns of sediment deposition in East Terrebonne coastal marshes and the impact of marsh management plans. Final Report, La. Dept. Nat. Res., Interagency Agreement No. 25101-90-18. Louisiana University Marine Consortium, Chauvin, LA 38pp. [NMFS]*

Reice, S. R. and A. E. Stiven. 1983. Environmental patchiness, litter decomposition and associated faunal patterns in a *Spartina alterniflora* marsh. Estuarine, Coastal and Shelf Science 16:559-571. [COE]

Rejmanek, M., C. E. Sasser and G. W. Peterson. 1988. Hurricane-induced sediment deposition in Gulf Coast marshes. Estuarine, Coastal and Shelf Science 27:217-222. [COE]*

Report of the Bureau of Commercial Fisheries Biological Laboratory. Galveston, TX. 1966. [COE]

Riley, T. Z. and T. A. Bookhout. 1990. Response of aquatic macroinvertebrates to early-spring drawdown in nodding smartweed marshes. Wetlands 10(2):173-185. [COE]

Roberts, D. W., and R. Sauvage. 1988. Lafourche Realty Company estuarine management program, 1987 environmental monitoring report. Baton Rouge: Coastal Environments, Inc. 26pp. [NMFS]

Rogers, S. M. 1989. Erosion control, marsh and low-cost breakwaters. Pages 751-764 in O. T. Magoon, H. Converse, D. Miner, L. T. Tobin and D. Clark, eds. Coastal Zone "89: Proceedings of the 6th Symposium on Coastal and Ocean Management, Vol. 1. Charleston SC, July 11-14, 1989. [COE]

Rogers, B. D. and W. H. Herke. 1985a. Temporal patterns and size characteristics of migrating juvenile fishes and crustaceans in a Louisian marsh. Research Report No.5. School of Foresty, Wildlife and Fisheries- Louisiana Agricultural Experiment Station, Louisiana State University, Baton Rouge, LA [COE]*

Rogers, B. D. and W. H. Herke. 1985b. Estuarine-dependent fish and crustacean movement and weir management. Pages 201-19 in C. F. Bryan, P.J. Zwank, and R.H. Chabreck, eds. Proceedings of the Fourth Coastal Marsh and Estuary Management Symposium. Baton Rouge: Louisiana State University, School of Forestry, Wildlife and Fisheries, and Louisiana Cooperative Fish and Wildlife Research Unit. [NMFS]*

Rogers, B. D., W. H. Herke, and E. E. Knudsen. 1992. Effects of three different water-control structures on the movements and standing stocks of coastal fishes and macrocrustaceans. Wetlands 12(2):106-120. [NMFS]*

Rogers, B. D., W. H. Herke, and E. E. Knudsen. 1987. Investigation of a weir-design alternative for coastal fisheries benefit. Final Report, Louisiana Cooperative Fish. Research Unit, School of Forestry, Wildlife and Fisheries, Louisiana State University, Baton Rouge, Louisiana. 98pp. [EPA, NMFS]*

Rogers, D. R. and B. D. Rogers. 1990. Effects of the Fina Laterre Marsh Management Plan on fishes and macrocrustaceans. Pages 482-521 in D. R. Cahoon and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075 [COE]

Rogers, D. R., B. D. Rogers, W. H. Herke. 1994. Structural marsh management effects on coastal fishes and crustaceans. Environmental Management 18(3):351-369. [COE, NMFS]

Rogers, D. R., B. D. Rogers, and W. H. Herke. 1992. Effects of a marsh management plan on fishery communities in coastal Louisiana. Wetlands 12(1):53-62. [COE, NMFS]

Rogers, D. R. 1989. The effects of rock and standard weirs on fish and macrocrustacean communities. M.S. Thesis, Louisiana State University, Baton Rouge, LA 141pp. [NMFS]*

Ross, W. M. and R. H. Chabreck. 1972. Factors affecting the growth and survival of natural and planted stands of Scirpus olneyi Ann. Proc. S.E. Assoc. G & F Comm. 26:178-188. [NRCS]

Rozas, L. P. 1993. Nekton of salt marshes of the southeastern region of the United States. Pages 528-537 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Rozas, L. P. and W. E. Odum. 1987. The role of submerged aquatic vegetation in influencing the abundance of nekton on contiguous tidal fresh-water marshes. J. Exp. Mar. Biol. Ecol. 114:289-300. [COE]

Rozas, L. P. and D. Reed. 1993. Nekton use of marsh-surface habitats in Louisiana (USA) deltaic salt marshes undergoing submergence. Marine Ecol. Prog. Series. 96:147-157. [COE]

Sabins, D. S. 1973. Diel studies of larval and juvenile fishes of the Caminada Pass area, Louisiana. Master's Thesis. Texas A&M University. [COE]

Sabins, D. S. and F. M. Truesdale. 1974. Diel and seasonal occurrence of immature fishes in a Louisiana tidal pass. Pages 161-170 in W. A. Rogers, ed. Proceedings of the Twenty-Eighth Annual Conference Southeastern Association of Game and Fish Commissioners. White Sulphur Springs, West Virginia. [COE]

Sasser, C. E. 1977. Distribution of vegetation in Louisiana coastal marshes as responses to tidal flooding. M. S. Thesis, Louisiana State University, Baton Rouge, LA. 40pp. [COE]*

Sasser, C. E., M. D. Dozier, and J. G. Gosselink. 1986. Spatial and temporal changes in Louisiana's Barataria Basin marshes, 1945-1980. Env. Man. 10(5):671-680. [USFWS]

Sasser, C. E., J. G. Gosselink, E.M. Swenson, and E. Evers. (submitted to Wetlands Ecology & Management, November, 1993). Hydrologic, vegetation, and substrate characteristics of floating marshes in sediment-rich wetlands of the Mississippi River Delta Plain, Louisiana. [NRCS]

Sasser, C. E., J. G. Gosselink, E.M. Swenson, C.M. Swarzenski, and N.C. Leibowitz. (submitted for publication). Vegetation, substrate and hydrology in floating marshes in the Mississippi River Delta Plain wetlands, USA: A basis for classification. [NRCS]

Sasser, C. E., J. Visser, E. Evers, and J. G. Gosselink. (in review, Ecology). Vegetation dynamics in a minerotrophic floating marsh in the Mississippi River Deltaic Plain, USA, 1979-1990. [NRCS]

Schaaf, W. E., D. S. Peters, D. S. Vaughn, L. Coston-Clements and C. W. Krouse. 1987. Fish population responses to chronic and acute pollution: The influence of life history strategies. Estuaries 10(3):267-275. [COE]

Seidensticker, E. and R. W. Nailon. 1987. The effects of shoreline erosion and the success of vegetative treatments in Texas coast habitats. Pages 235-258 in Proc. Third Water Quality and Wetland Management Conf. [NRCS]*

Serpas, R. 1989. Fisheries sampling and monitoring of Vermilion Bay Land Company marsh management plan, Vermilion Parish, Louisiana. Preliminary Report. Baton Rouge, La., La. Dept. Nat. Res., Coastal Mgt. Div. 8pp. [NMFS]

Shiflet, T. N. 1963. Major ecological factors controlling plant communities in Louisiana marshes. J. Range Mgt. 16(5):231-234. [NRCS]*

Shirley, Mark (Ed). 1995. Proceedings of the Symposium: economics in natural resource management: valuing fish, wildlife and habitats, October 4-5, 1994. Louisiana State University-Agricultural Center, Baton Rouge LA

Simmering, R., B. Craft, J. Woodard, and D. Clark. 1988. An evaluation of the Tenneco Laterre mitigation bank management plan. Pages 319-329 <u>in</u> W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [COE, NRCS]*

Sinicrope, T., Hine P., Warren, R., and Niering, W. 1990. Restoration of an impounded salt marsh in New England. Estuaries 13(1):25-30.

Smart, R. M., and J. W. Barko. 1980. Nitrogen nutrition and salinity tolerance of *Distichlis spicata* and *Spartina alterniflora*. Ecology 61(3):630-638. [COE]*

Smith, R. L. 1980. Ecology and field biology. Third Edition. Harper & Row, Publishers. New York. [COE]*

Smith, E. R. 1970. Evaluation of a leveed Louisiana marsh. Pages 265-275 <u>in</u> Transactions of the thirty-fifth North American wildlife and natural resources conference. March 22-25, 1970. Chicago, Illinois. [NRCS]

South Carolina Sea Grant Consortium. 1994. Protecting Public Trust Areas In....A Changing Coastal Environment. Coastal Heritage 8(4):3-8. [COE]

Spicer, B., D. Clark, and J. deMond. 1986. Marsh management and the Louisiana Coastal Resources Program. Miscellaneous Publication of the Coastal Management Division, Louisiana Department of Natural Resources, Baton Rouge, LA [COE]*

Spiller , S. F. 1975. A comparison of wildlife abundance between areas influenced by weirs and control areas. MS Thesis. School of Forestry and Wildlife Management, LSU, Baton Rouge LA 94 ppg.

Spiller, S. F. and R. H. Chabreck. 1975. Wildlife populations in coastal marshes influenced by weirs. Proc. Southeast. Assoc. Game & Fish Comm. 29:518-525. [NRCS]*

Sprunt, A., IV. 1967. Values of the South Atlantic and Gulf Coast marshes and estuaries to birds other than waterfowl. Pages 64-72 in J. D. Newsom, ed. Proceedings of the marsh and estuary symposium. July 19-20, 1967. Louisiana State University, Baton Rouge, LA. [NRCS]*

St.Pe, K. and R. A. DeMay. 1993. Priority problems of the Barataria-Terrebonne estuarine complex. Pages 709-719 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Stakhiv, E. Z. 1986. Cumulative impact analysis for regulatory decisionmaking. Pages  in J. A. Kusler and P. Retinger, eds. Proc. Natl. Wetlands Assess. Symp. ASWM Tech. Rpt. No. 1. [COE]

Steller, D. L., B. Good, C. Clark, K. Bahlinger, J. Rasi and G. Steyer. 1993. Coastal restoration: Louisiana's saving grace. Pages 2111-2125 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Suhayda, J. N., A. Bailey, H. H. Roberts, S. Penland, and G. Kuecher. 1993. Subsidence properties of holocene sediments: South Louisiana. Pages 1215-1229 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Suhayda, J., M. Young, and R. Xugui. 1989. Simulation study of natural and man-made changes in estuarine systems. Pages 82-85 in Symp. Proc. Applied Simulation & Modeling, Santa Barbara, CA. [NRCS; unable to verify citation]

Swarzenski, C. 1992. Mat movement in coastal Louisiana marshes: Effect of salinity and inundation on vegetation and nutrient levels. Ph.D. Dissertation, Ecological Sciences, Old Dominion University, Norfolk, VA 51pp. [USFWS]

Swarzenski, C. M., E. M. Swenson, E. Sasser and J. G. Gosselink. 1991. Marsh mat flotation in the Louisiana Delta Plain. Journal of Ecology 79:999-1011. [NRCS]

Swarzenski, C. 1987. Floating marshes in Louisiana: substrate and hydrological characterization. Masters Thesis, Dept. of Marine Sciences, Louisiana State University, Baton Rouge, LA. 61pp. [USFWS]

Sweeney, K. P., M. Swan, K. M. Wicker and J. Day. 1990. Evaluation of marsh management effectiveness: Analysis of habitat change. Pages 281-354 in D. R. Cahoon and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]

Swenson, E. M., and R. E. Turner. 1987. Spoil banks: Effects on a coastal marsh water level. Estuarine, Coastal and Shelf Science 24:599-609. [EPA]

Swenson, E. M. and W. J. Wiseman, Jr. 1987. Movement of salt water through a marsh substrate: A preliminary analysis. Poster: 8th Annual Meeting of the Society of Wetland Scientists, Seattle, Washington, May 26-29, 1987. [COE]

Talbot, W. R. and R. W. Tuttle. 1992. Engineering field handbook, Chapter 13: "Wetland restoration, enhancement, or creation," USDA, Soil Conservation Service. Pages 292-295 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Taniguchi, A. K. 1986. Chapter 11: Microplankton abundance. Pages 203-231 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Status and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]*

Taylor, K. L. and J. B. Grace. 1992. Effects of nutria herbivory on three coastal marsh communities along a salinity gradient. Pages 125-129 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Taylor, T. S. 1978. Spring foods of migrating blue-winged teals on seasonally flooded impoundments. J. Wildl. Manage. 42:900-903. [NRCS]*

Taylor, K. L., J. B. Grace, G. R. Guntenspergen and A. L. Foote. 1992. Effects of fire and herbivory in an intermediate marsh community, Little Lake, Louisiana. Pages 289-291 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]*

Teal, J. and M. Teal. 1969. Life and death of a salt marsh. An Audubon/Ballantine Book. New York. [COE]

Teels, B. M. 1992. The role of the USDA Soil Conservation Service in the stewardship of wetlands. Pages 45-50 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]

Thibodeau, F. R. and N. H. Nickerson. 1985. Changes in a wetland plant association induced by impoundment and draining. Biol. Conserv. 33:262-279. [EPA]

Tompkins, M. E. 1987. South Carolina's diked tidal wetlands: The persisting dilemmas. Coastal Management 15:135-155. [COE]

Trepagnier, C. M., B. Good, G. D. Steyer, W. B. Sutton, and M. Windham. 1992. Evaluation of three crevasse splay marsh creation projects at the Mississippi River Delta. Pages 115-119 in M. C. Landin, ed. Wetlands: Proceedings of the 13th Annual Conference of the Society of Wetlands Scientists, New Orleans, LA. South Central Chapter, Society of Wetlands Scientists, Utica, MS. USA. 990pp. [NRCS]

Turner, M. G. 1987. Effects of grazing by feral horses, clipping, trampling, and burning on a Georgia salt marsh. Estuaries 10(1):54-60. [COE]

Turner, R. E. 1991. Tide gauge records, water level rise and subsidence in the northern Gulf of Mexico. Estuaries 14(2):139-147. [COE]*

Turner, R. E. 1987. Relationship between canal and levee density and coastal land loss in Louisiana. U.S. Fish and Wildl. Serv. Biol. Rep. 85(14). 58pp. [COE]*

Turner, R. E. 1977. Intertidal vegetation and commercial yields of Penaeid shrimp. Trans. Am. Fish. Soc. 106(5):411-416. [NRCS]*

Turner, R. E., D. R. Cahoon, and J. H. Cowan, Jr. 1986. Marsh management needs and myths in Louisiana. Proc. National Wetlands Symposium: Mitigation of Impacts and Losses. Assoc. State Wetland Managers, Inc., New Orleans, Oct. 1986. [EPA]*

Turner, R. E., J. W. Day and J. G. Gosselink. 1989. Weirs and their effects in coastal Louisiana (exclusive of fisheries). Pages 151-163 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues--proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [COE, NMFS]*

Turner, R. E., and C. Neill. 1984. Revisiting the marsh after 70 years of impoundment. Pages 309-322 in R. J. Varnell, ed. Water Quality and Wetland Management Conference Proceedings. New Orleans, LA., August 4-5, 1983. Tulane Univ. Press, New Orleans. [EPA]

Turner, R. K., D. Pearce and I. Bateman. 1993. Environmental economics: An elemantary introduction. The John Hopkins University Press. 328 ppg. [COE]*

Turner, R. E. and Y. S. Rao. 1990. Relationships between wetland fragmentation and recent hydrologic changes in a deltaic coast. Estuaries 13(3):272-281. [COE]*

United Sates Department of Agriculture, Soil Conservation Service. 1993. Calcasieu-Sabine: Cooperative River Basin Study Report. Soil Conservation Service, Alexandria, LA. [COE]*

Van Heerden, I. L., G. P. Kemp, and J. N. Suhayda. 1993. The importance and role of barrier islands to coastal wetlands in Terrebonne. LSU-CEEER. [NRCS; unable to verify citation]

Vince, S. W. and I. Valiela. 1981. An experimental study of the structure of herbivorous insect communities in a salt marsh. Ecology 62(6):1662-1678. [COE]

Viosca, P. Jr. 1928. Louisiana wet lands and the value of their wild life and fishery resources. Ecology 9:216-229. [NRCS]*

Wade, T. L., E. L. Atlas, J. M. Brooks, M. C. Kennicutt II, R. G. Fox, J. Sericano, B. Garcia-Romero, and D. DeFreitas. 1988. NOAA Gulf of Mexico status and trends program: Trace organic contaminant distribution in sediments and oysters. Estuaries 11(3):171-179. [COE]

Wang, F. C., T. Lu and W. B. Sikora. 1993. Intertidal marsh suspended sediment transport processes, Terrebonne Bay, Louisiana. Journal of Coastal Research 9(1):209-220. [COE]

Wang, F. C. and M. Wang. 1993. Depositional sediment on intertidal marshes near Terrebonne Bay and Atchafalaya Bay, Louisiana. Pages 196-210 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Ward, G. and G. J. FitzGerald. 1983. Fish predation on the macrobenthos of tidal salt marsh pools. Can. J. Zool. 61:1358-1361. [COE]

Weaver, J. E., and L. F. Holloway. 1974. Community structure of fishes and macrocrustaceans in ponds of a Louisiana tidal marsh influenced by weirs. Contributions in Marine Science 18:57-69. [NMFS]

Webb, J. W. 1983. Soil water salinity variations and their effects on *Spartina alterniflora*. Contributions in Marine Science 26:1-13. [COE]

Weller, M. W. 1978. Management of freshwater marshes for wildlife. Pages 267-284 in R. E. Good, D. F. Whigham, and R. L. Simpson, eds. Freshwater Wetlands: Ecological Processes and Management Potential. Academic Press, Inc. 1978. [COE]

Welling, C. H., R. L. Pederson and A. G. Van Der Volk. 1988. Recruitment from the seed bank and the development of zonation of emergent vegetation during a drawdown in a prairie wetland. Journal of Ecology 76:483-496. [COE]

Wengert, M. W., Jr. 1972. Dynamics of the brown shrimp Penaeus azetecus Ives 1891, in the estuarine area of Marsh Island, Louisiana in 1971. Masters Thesis, Louisiana State University, Baton Rouge, LA. 94pp. [NMFS]

Wenner, E. L. 1986a. Chapter 12: B. Benthic macrofauna. Pages 255-298 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]

Wenner, E. L. 1986b. Chapter 13: B. Decapod crustacean community. Pages 361-13 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]*

Wenner, E. L. and H. R. Beatty. 1988. Macrobenthic communities from wetland impoundments and adjacent open marsh habitats in South Carolina. Estuaries 11(1):29-44. [COE]

Wenner, C. A., J. C. McGovern, R. Martore, H. R. Beatty and W. A. Roumillat. 1986. Chapter 14: Ichthyofauna. Pages 415-526 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. South Carolina Sea Grant Consortium, Charleston, SC 611pp. [COE]

Wetland Conservation and Restoration Task Force. 1990. Coastal Wetlands Conservation and Restoration Plan (Fiscal Year 1990-91). Submitted to the House and Senate Committees on Natural Resources. Produced by Coastal Environments, Inc., Baton Rouge, LA. [COE]

White, D. A., T. E. Weiss, J. M. Trapani, and L. B. Thien. 1978. Productivity and decomposition of the dominant salt marsh plants in Louisiana. Ecology 59:751-759. [NRCS]

White House Office on Environmental Policy. 1993. Protecting America's wetlands: A fair, flexible and effective approach. WH28 08-26-1993 18:55 [77060], 15pp. [NRCS]

Wicker, K. M., D. Davis and D. Roberts. 1983. Rockefeller State Wildlife Refuge and Game Preserve--evaluation of wetland management techniques. Louisiana Department of Natural Resources, Coastal Management Section, Baton Rouge, LA. 51pp. [NRCS, USFWS]

Wiegert, R. G., A. G. Chalmers, and P. F. Randerson. 1983. Productivity gradients in salt marshes: The response of *Spartina alterniflora* to experimentally manipulated soil water movement. Oikos 41:1-6. [COE]

Wilkins, J. 1990. Administrative framework. Pages 19-57 in D. R. Cahoon and C. E. Groat, eds. A Study of Marsh Management Practice in Louisiana, Vol. III. Final report submitted to Minerals Management Service, New Orleans, LA. Contract No. 14-12-0001-03410. OCS Study/MMS 90-0075. [COE]*

Wilkins, J. G. and M. Wascom. 1989. A legal review of some Louisiana wetland management activities. Pages 365-378 in W. G. Duffy and D. Clark, eds. Marsh management in coastal Louisiana: Effects and issues-- proceedings of a symposium. U.S. Fish and Wildlife Service and Louisiana Department of Natural Resources. U. S. Fish Wildl. Serv. Biol. Rep. 89(22). 378pp. [COE, NMFS]*

Williams, S. J., S. Penland and H. Roberts. 1993. Processes affecting coastal wetland loss in the Louisiana deltaic plain. Pages 211-219 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

Wiseman, W. J. and M. Inoue. 1993. Salinity variations in two Louisiana estuaries. Pages 1230-1242 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]*

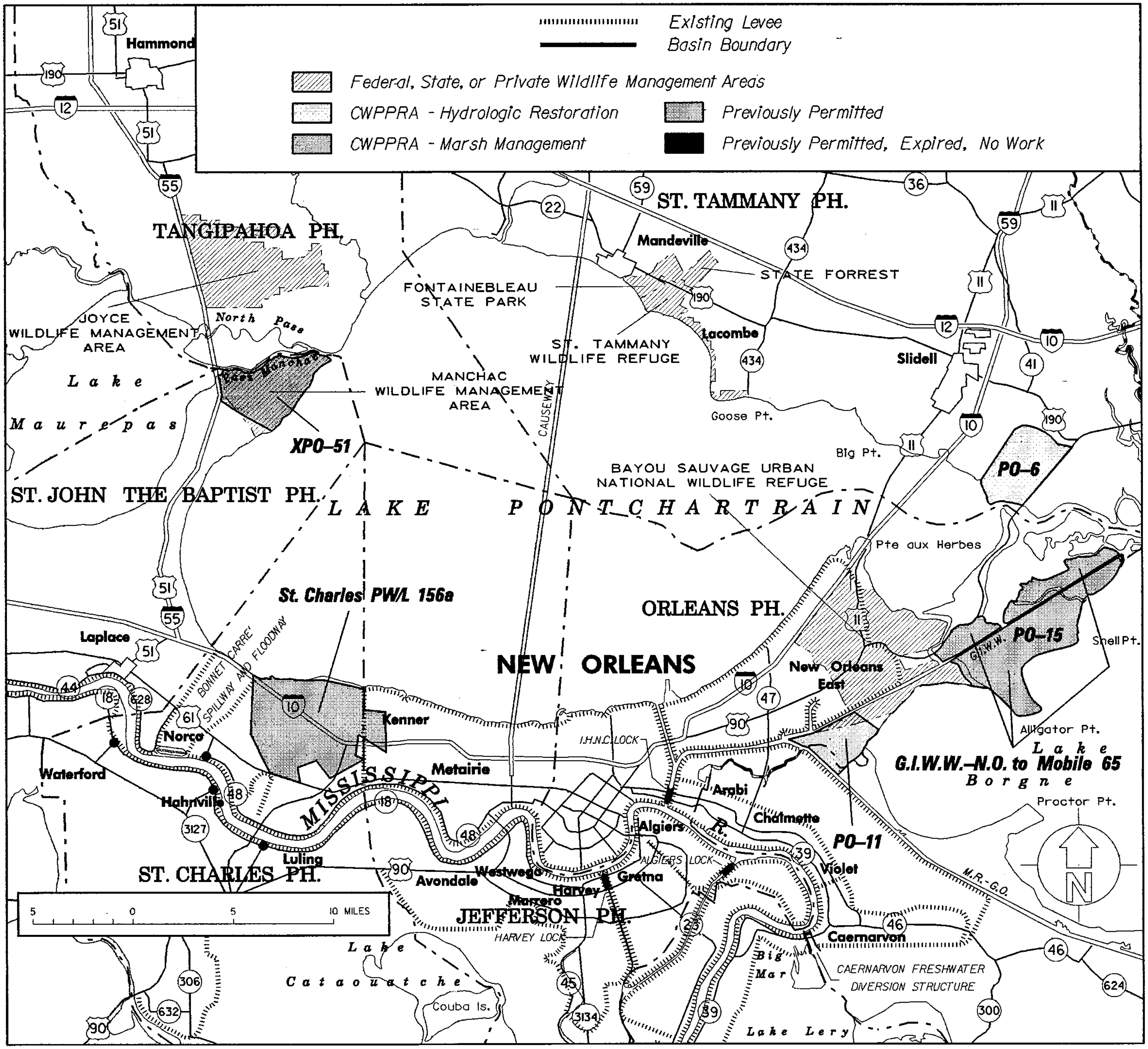
Wiseman, W. J., Jr., E. M. Swenson, J. Power. 1990. Salinity trends in Louisiana estuaries. Estuaries 13(3):265-271. [COE]

Wolfe, D. A. , M. A. Champ, D. A. Flemer and A. J. Mearns. 1987. Long-term biological data sets: Their role in research, monitoring and management of estuarine and coastal marine systems. Estuaries 10(3):181-193. [COE]

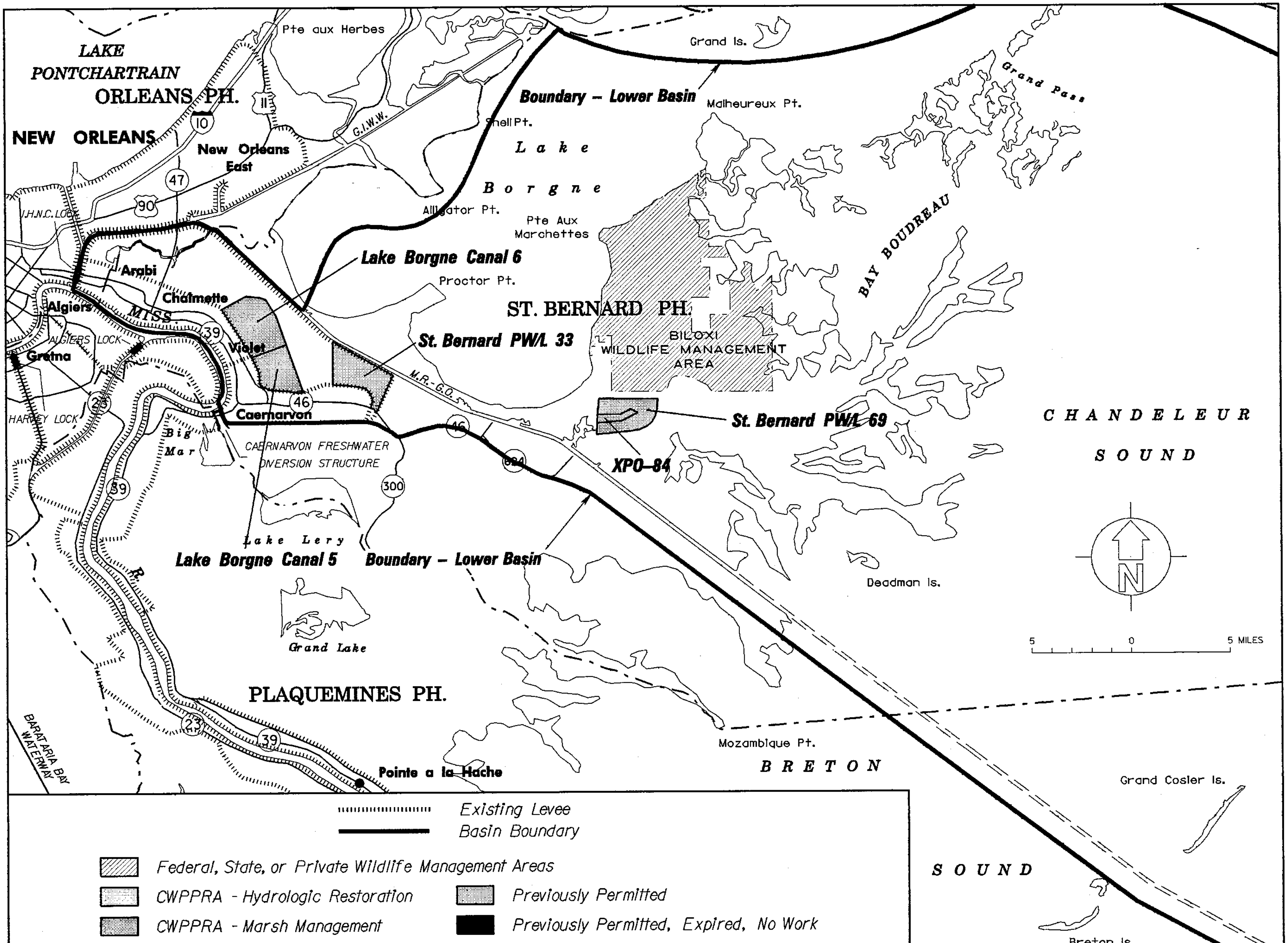
Zimmerman, R. L. and T. J. Minello. 1993. Watershed effects on the value of marshes to fisheries. Pages 538-547 in O. T. Magoon, W. S. Wilson, H. Converse and L. T. Tobin, eds. Coastal Zone '93: Proceedings of the Eighth Symposium on Coastal and Ocean Management, Vol 1. July 19-23, New Orleans, LA. American Society of Civil Engineers. New York, New York. [COE]

Zingmark, R. G. 1986. Chapter 7: Production of microbenthic algae. Pages 179-202 in M. R. DeVoe and D. S. Baughman, eds. South Carolina Coastal Wetland Impoundments: Ecological Characterization, Management, Statyus and Use. Vol. II: Technical Synthesis. Pub. No. SC-SG-TR-86-2. So. Carolina Sea Grant Consort., Charleston, SC 611pp [COE]*

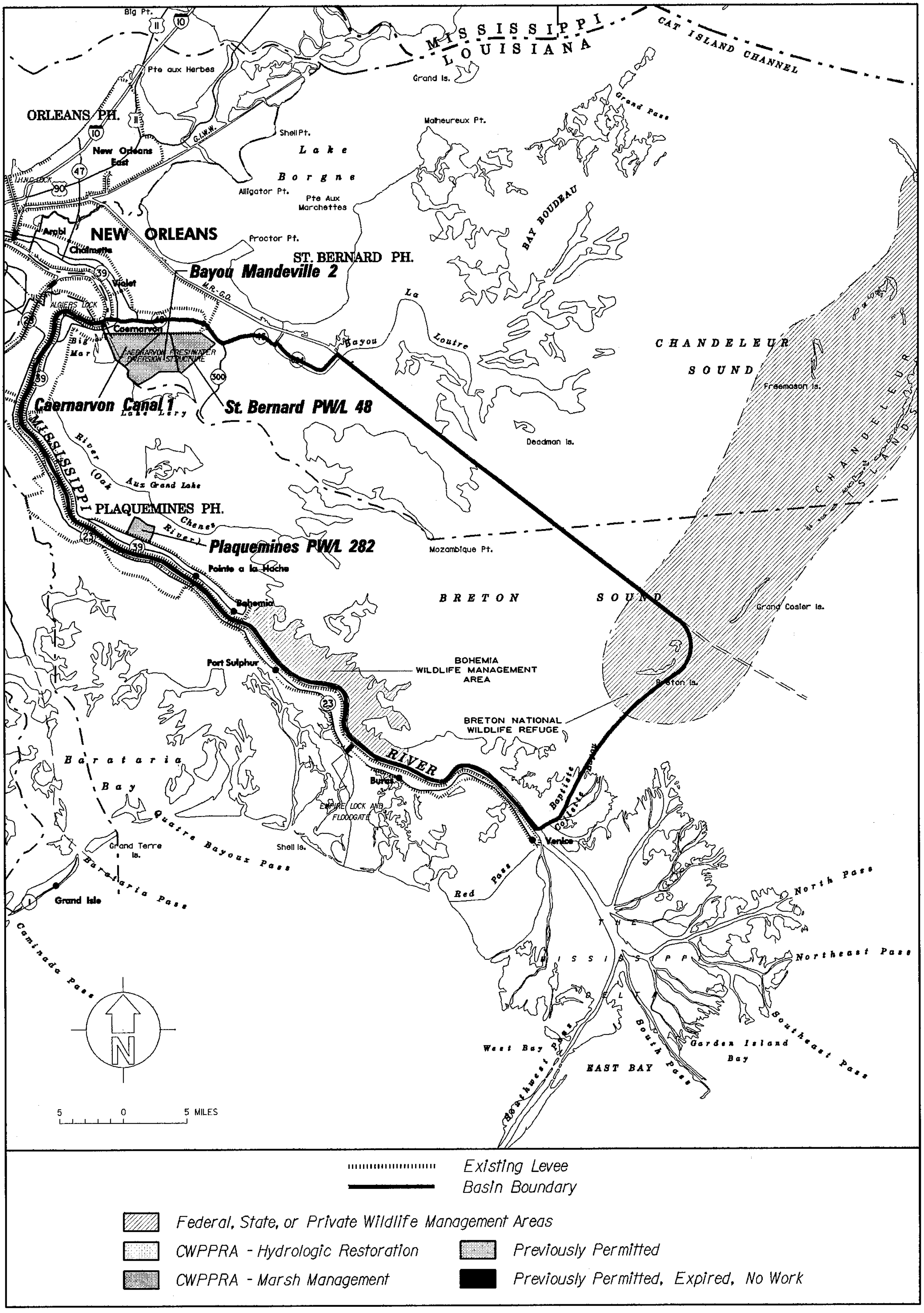
# PLATES




Pontchartrain Basin (Basin No. 1)




**Pontchartrain Basin (Basin No. 1)**




**Breton Sound Basin (Basin No. 2)**

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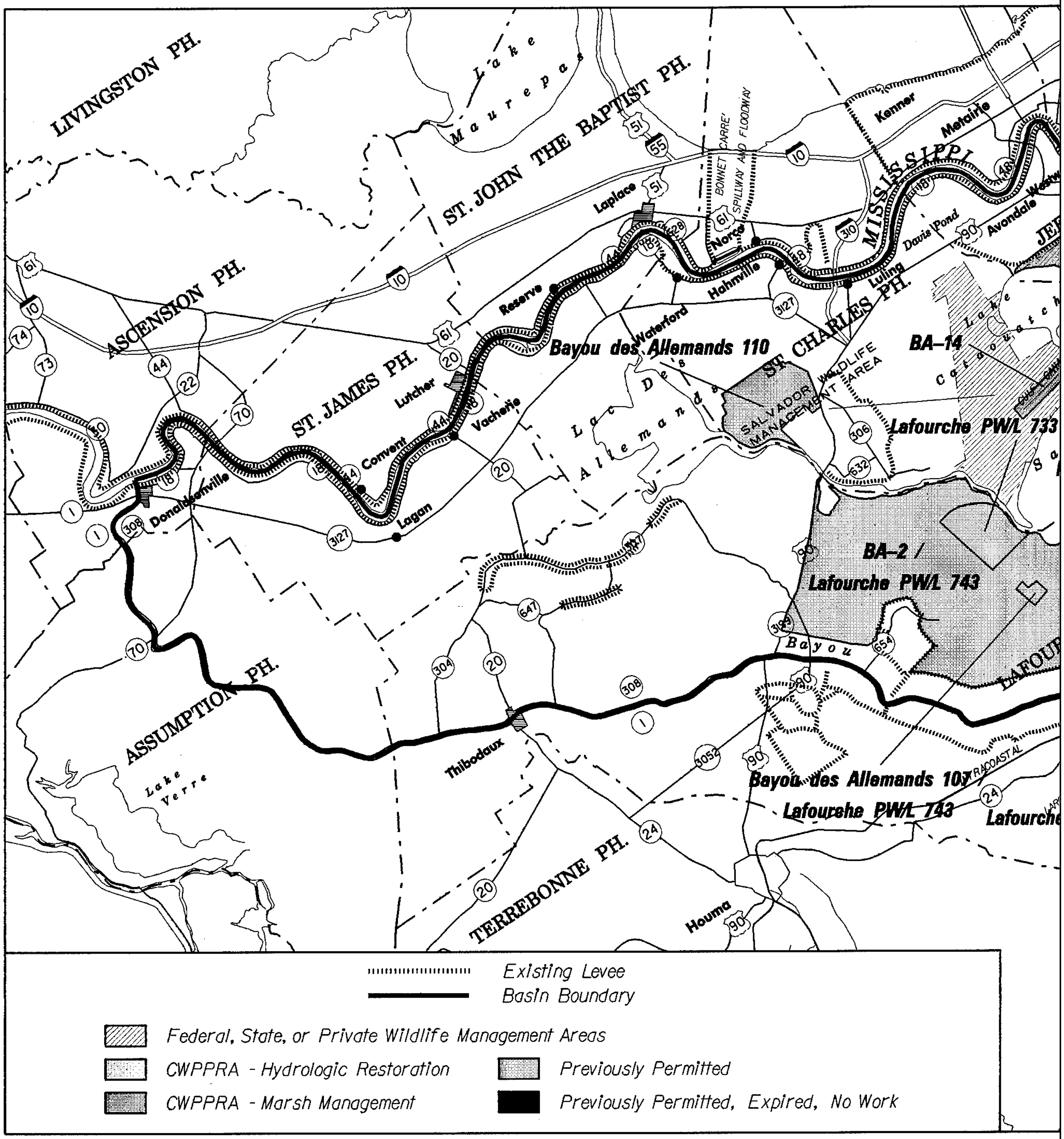


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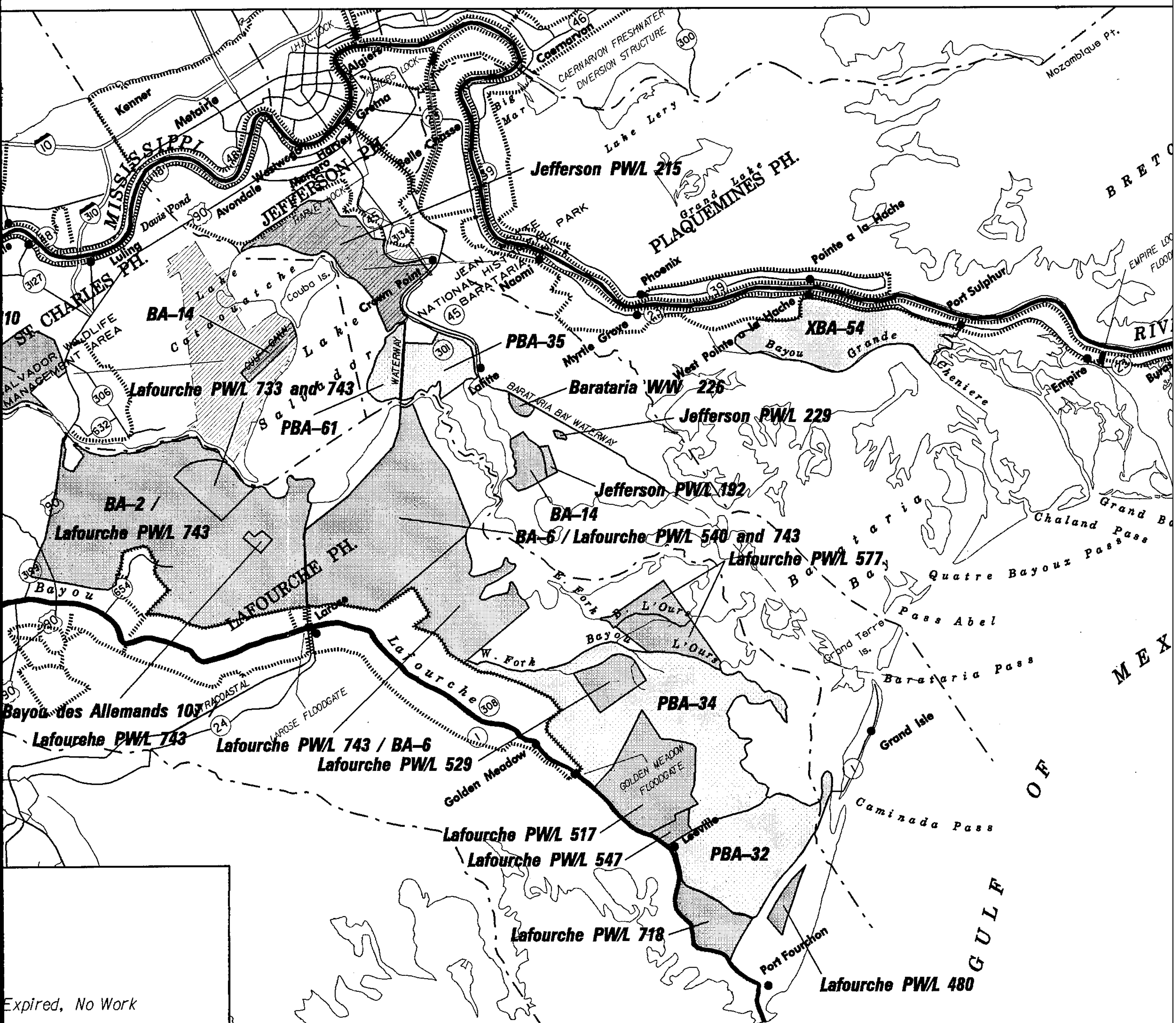

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PBA-35
XBA-54
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Jefferson PW/L 229
Lafourche PW/L 733 and 743
PBA-61
Jefferson PW/L 192
BA-2 /
Lafourche PW/L 743
BA-14
BA-6 / Lafourche PW/L 540 and 743
Lafourche PW/L 577
LAFOURCHE PH.
PBA-34
Bayou des Allemands 107
Lafourche PW/L 743
Lafourche PW/L 743 / BA-6
Lafourche PW/L 529
Lafourche PW/L 517
Lafourche PW/L 547
PBA-32
Lafourche PW/L 718
Lafourche PW/L 480
MISSISSIPPI
JEFFERSON PH.
PLAQUEMINES PH.
ST. CHARLES PH.
Kenner
Metairie
Luling
Avondale
Westwego
Marrero
Harvey
Gretna
Algiers
Belle Chasse
Caernarvon
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Lake Lery
Big Mar
Davis Pond
Lake Cataouatche
Lake Salvador
Couba Is.
Crown Point
JEAN LAFITTE NATIONAL HIST. PARK
Naomi
Phoenix
Pointe a la Hache
West Pointe a la Hache
Myrtle Grove
Port Sulphur
Empire
Lafitte
BARATARIA BAY WATERWAY
Bayou Grande Cheniere
Barataria Bay
Chaland Pass
Quatre Bayoux Pass
Pass Abel
Grand Terre Is.
Barataria Pass
Grand Isle
Caminada Pass
GULF OF MEX
Mozombique Pt.
Larose
LAROSE FLOODGATE
Golden Meadow
GOLDEN MEADOW FLOODGATE
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W. Fork
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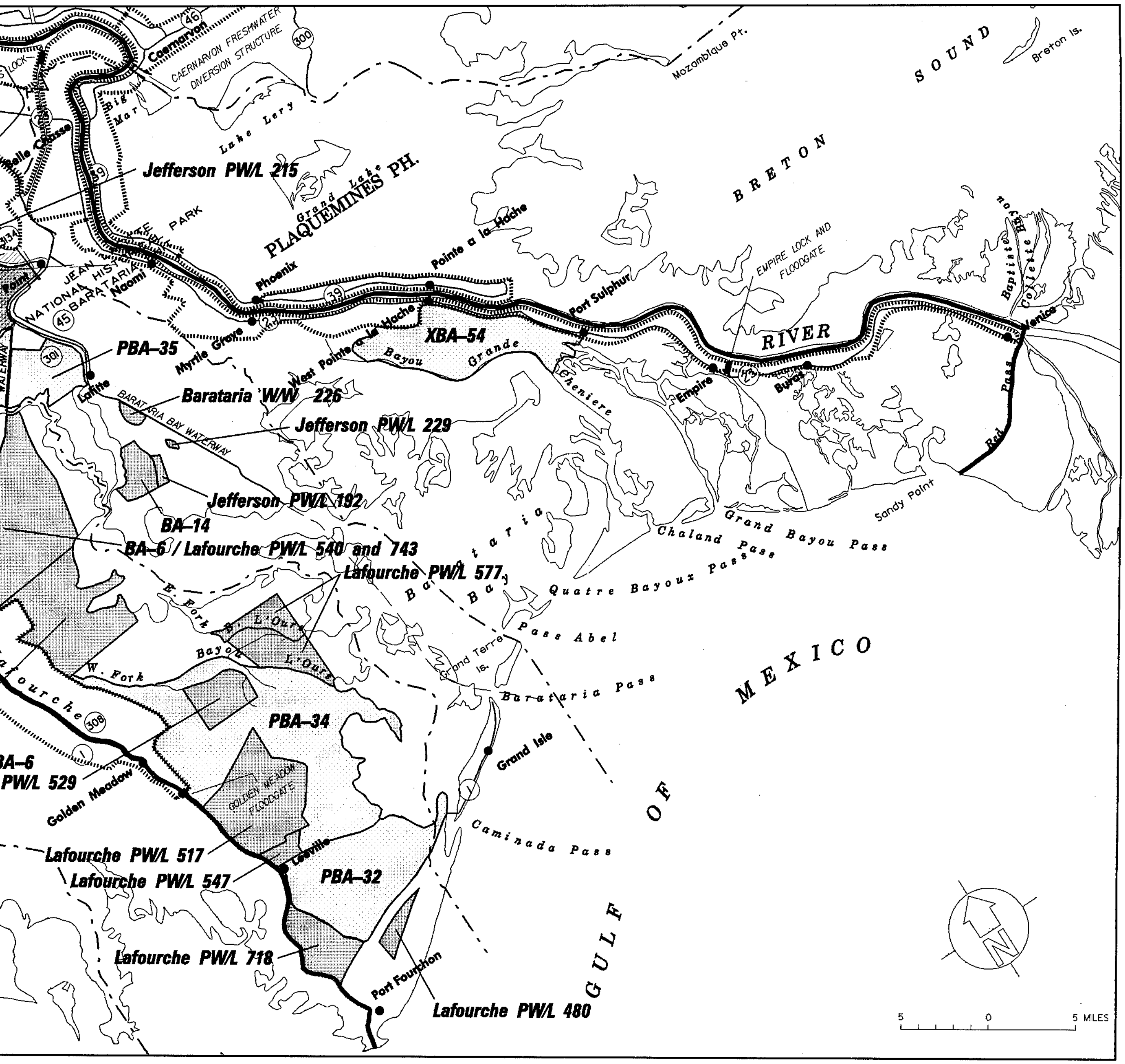
3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PLAQUEMINES PH.
Lake Lery
Grand Lake
Big Mar
CAERNARVON FRESHWATER DIVERSION STRUCTURE
Caernarvon
Mozambique Pt.
SOUND
Breton Is.
BRETON
EMPIRE LOCK AND FLOODGATE
Pointe a la Hache
Phoenix
Naomi
JEAN LAFITTE NATIONAL HISTORICAL PARK
BARATARIA
Port Sulphur
XBA-54
RIVER
Venice
Baptiste Collette Bayou
PBA-35
Myrtle Grove
West Pointe a la Hache
Bayou Grande
Cheniere
Empire
Buras
Lafitte
Barataria W/W 226
BARATARIA BAY WATERWAY
Jefferson PW/L 229
Jefferson PW/L 192
BA-14
BA-6 / Lafourche PW/L 540 and 743
Lafourche PW/L 577
Red Pass
Sandy Point
Grand Bayou Pass
Chaland Pass
Barataria Bay
Quatre Bayoux Pass
E. Fork B. L'Ours
Bayou L'Ours
W. Fork
Pass Abel
Grand Terre Is.
Barataria Pass
MEXICO
OF
GULF
PBA-34
Grand Isle
BA-6
PW/L 529
Golden Meadow
GOLDEN MEADOW FLOODGATE
Caminada Pass
Lafourche PW/L 517
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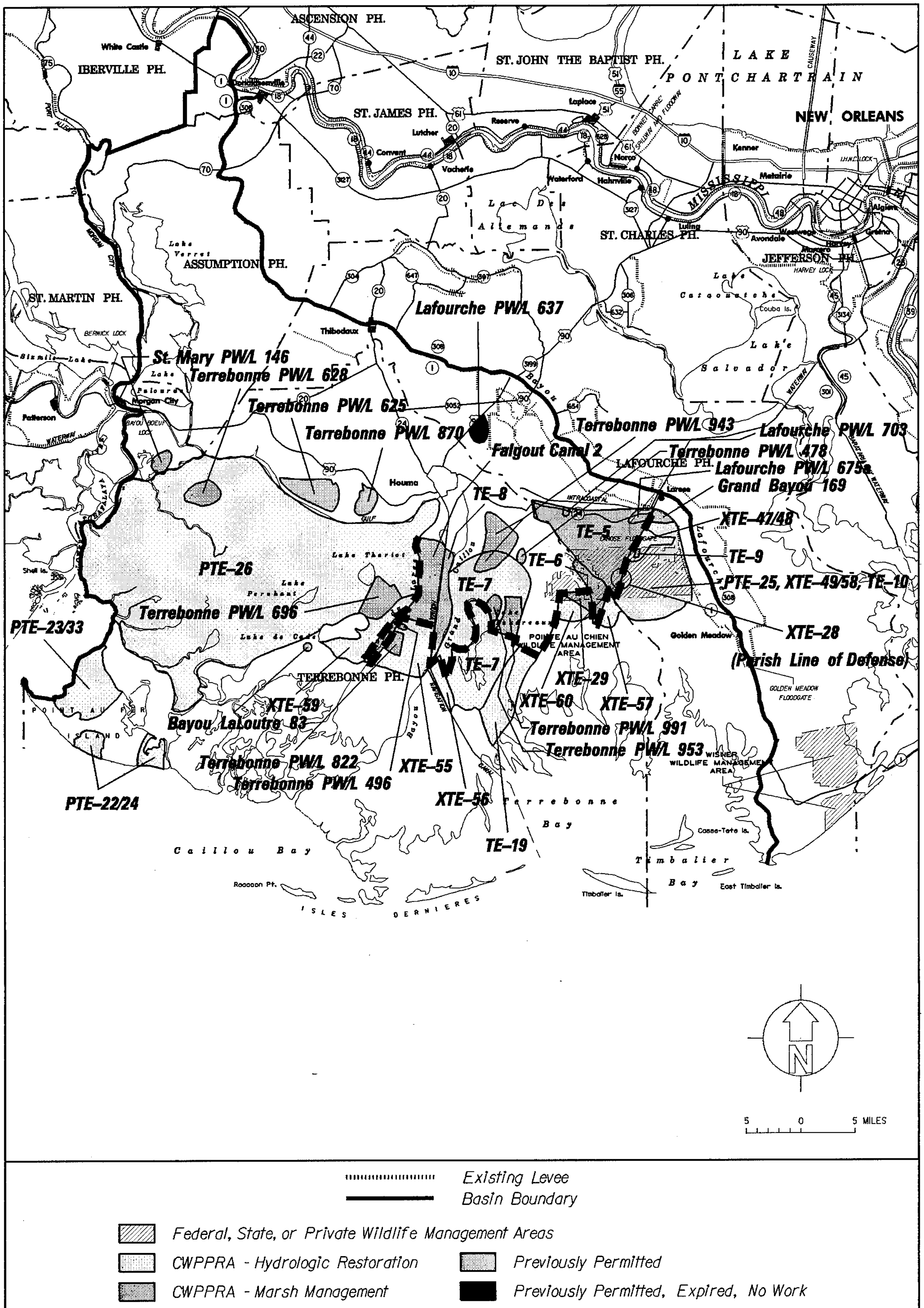
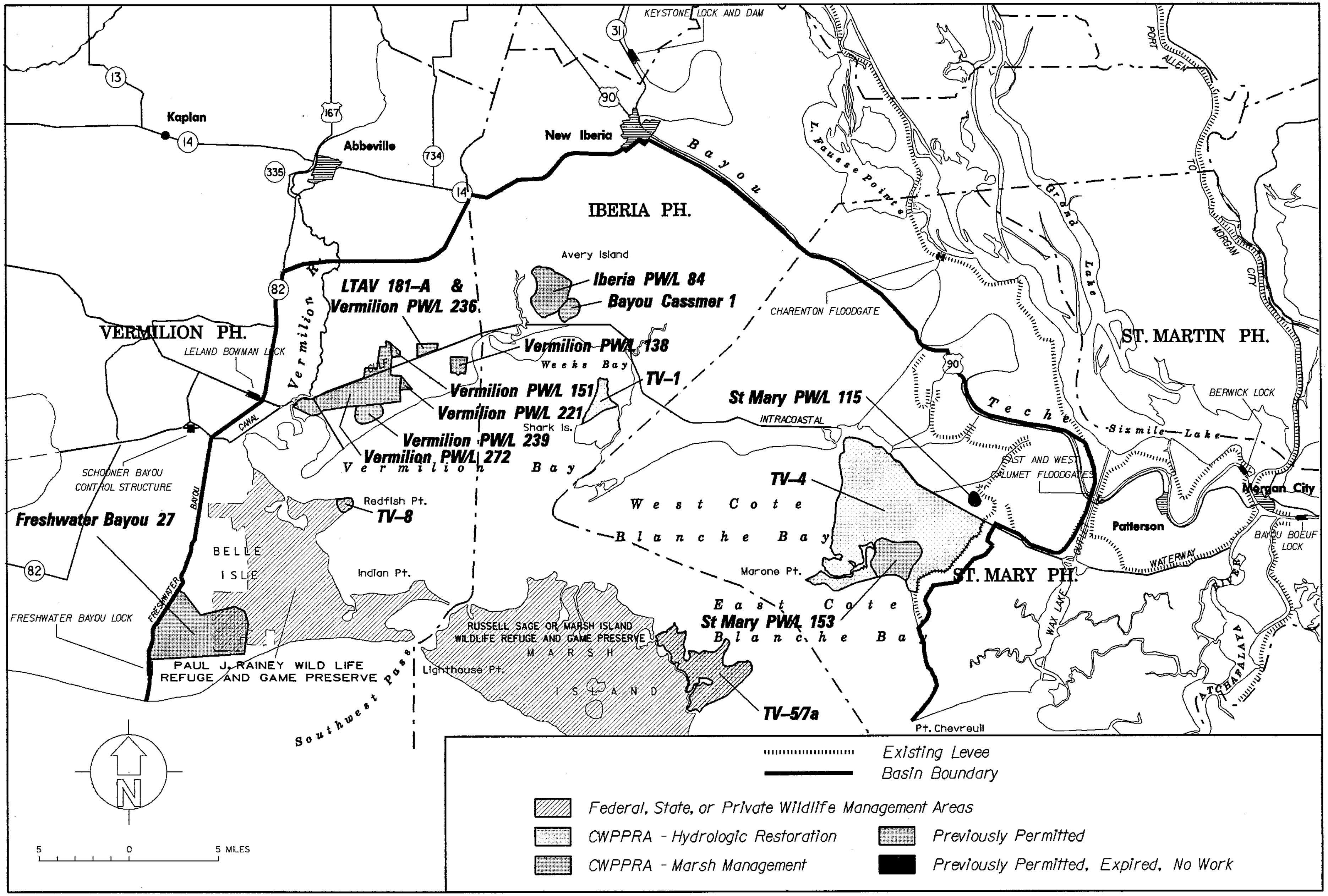
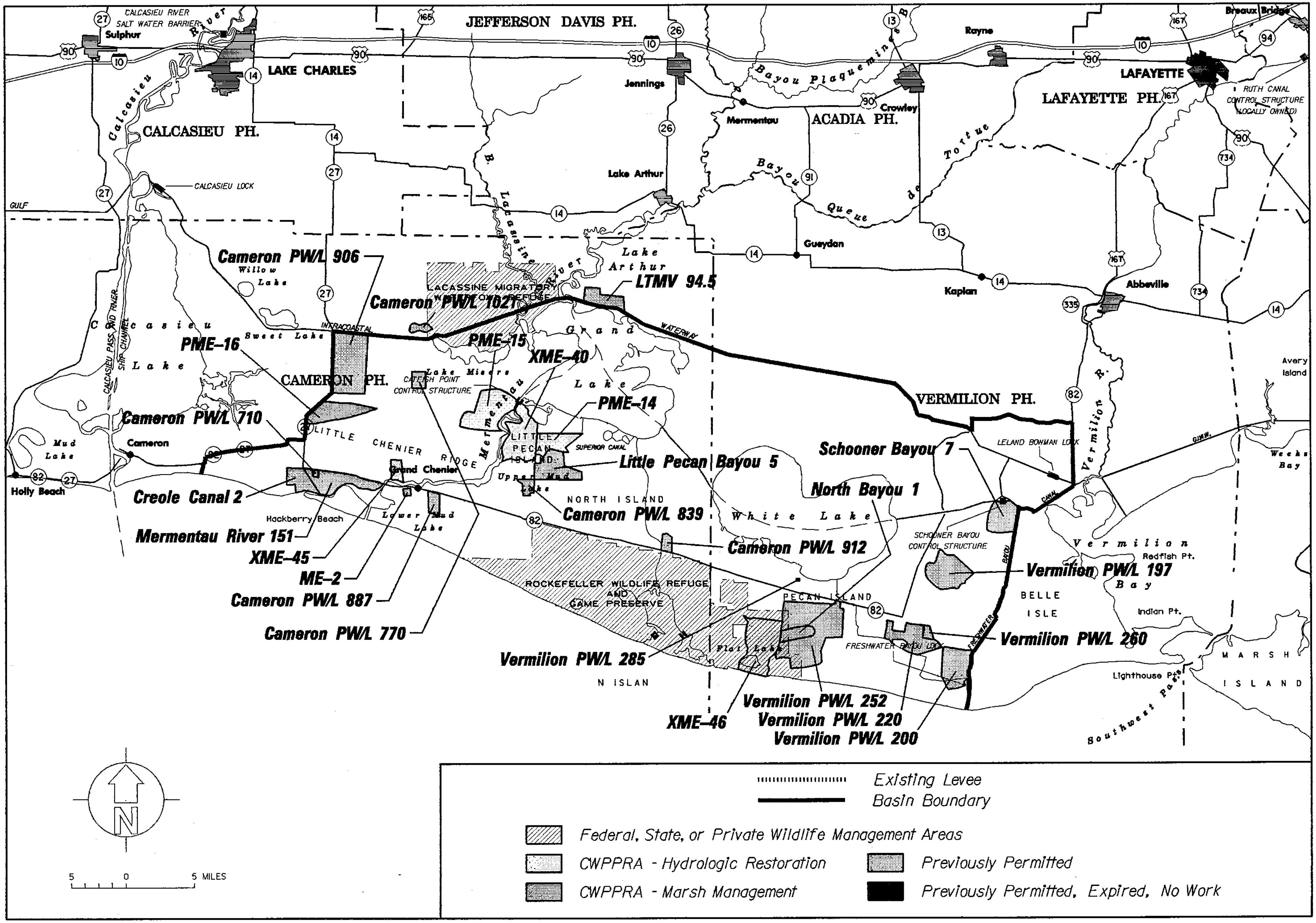


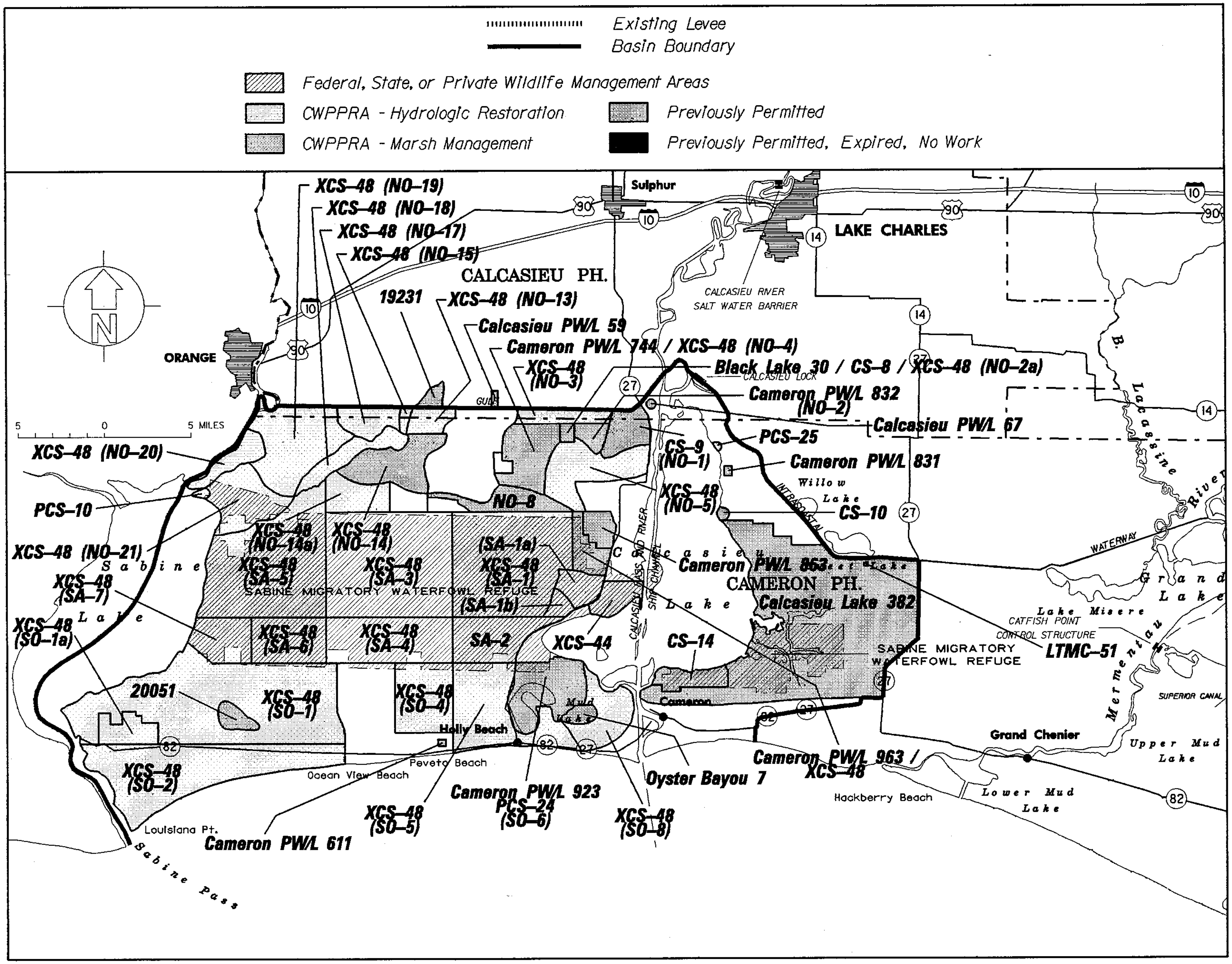

**Terrebonne Basin (Basin No. 5)**




**Teche – Vermilion Basin (Basin No. 7)**




Mermentau Basin (Basin No. 8)



Calcasieu – Sabine Basin (Basin No. 9)

## 9.0. ***APPENDIXES***

A - NOD's Permit Data
B - FWS's Permit Process Narrative
C - NMFS's Permit Process Narrative
D - NRCS's Project Process Narrative
E - LaDNR's Permit Process Narrative
F - EPA's Permit Process Narrative
G - NOD's Permit Processing Narrative
H - Basin-by-basin Landscape Characterizations
I - Birds
J - Socioeconomic Appendix
K - Prime and Unique Farmlands
L - Cultural Appendix
M - Management Structures: A overview of the design, impacts and effects of several water control structures used for marsh management/hydrological restoration.
N - Reserved for Threatened and Endangered Species/Marine Mammals

# A - NOD's Previously Permitted Projects Data Base

Key to Tables

STRUCTURE URE TYPES

C - culvert FC - fixed crest weir
LE - levee VC - variable crest weir
PL - plug FG - flapgate
SG - screwgate SW - slotted weir

MARSH TYPES

F - fresh marsh
I - intermediate marsh
B - brackish marsh
S - Saline marsh

PURPOSE

WF - waterfowl/furbearers (targeted wildlife)
MR - reduce marsh deterioration/marsh restoration
MA - mariculture related activities
RE - research
FB - fur bearers

STATUS

Uppercase = Confirmed
Lowercase = Assumed

C = complete
P = parts installed
E = expired
NE = not expired
NW = no work

| PERMIT NO. | APPLICANT | STATUS | MARSH TYPE | ACREAGE |
|---|---|---|---|---|
| Cameron Ph w/l 563 | Cameron Rec. Dist 6 | WITHDRAWN | B | 44 |
| Cameron Ph w/l 564 | Cameron Rec. Dist 6 | WITHDRAWN | B | 87 |
| Cameron Ph w/l 623 | Miami Corp. | WITHDRAWN | F/I | 59,301 |
| Cameron Ph w/l 727 | Chachere, M. | WITHDRAWN | F/I | 1,700 |
| Cameron Ph w/l 824 | Bonsall, T. | WITHDRAWN | I/B | 520 |
| Cameron Ph w/l 870 | Green, Q. | WITHDRAWN | I/B | 1,487 |
| Cameron Ph w/l 888 | Miller Estates | NO RECORD | B | 400 |
| Cameron Ph w/l 896 | Smith, V. | NO RECORD | B | 1,400 |
| Cameron Ph w/l 931 | Amoco | NO RECORD | B | 786 |
| Freshwater Bayou 28 | Landry, A. | WITHDRAWN | B | 320 |
| Jefferson Ph w/l 193 | LL&E | WITHDRAWN | B/S | 3,838 |
| LTMA 1216 | Cont. Land & Fur | WITHDRAWN | F | 20,410 |
| Lafourche Ph w/l 487 | Melancon, R. | WITHDRAWN | F/I | 902 |
| Lafourche Ph w/l 527 | Sea Farms | WITHDRAWN | S | 1,700 |
| Lafourche Ph w/l 647 | Adams, C. | WITHDRAWN | I | 685 |
| Lafourche Ph w/l 675 | Martin, Andrew & James | WITHDRAWN | F | 1,000 |
| Lafourche Ph w/l 742 | Lafourche Telephone | WITHDRAWN | I | 2,500 |
| Lake Maurepas 44 | Artra | WITHDRAWN | CT | 300 |
| Mermentau River 177A | Cameron GDD 4 | WITHDRAWN | B/S | 520 |
| Mermentau River 177 | Cameron GDD 5 | DENIED | B/S | 520 |
| St. John Ph w/l 34 | Laplace Drain. Dist. | WITHDRAWN | CT | 2,400 |
| Terrebonne Ph w/l 890 | Smyth-Church | WITHDRAWN | B/S | 3,160 |
| Vermilion Ph w/l 216 | Pettit, M. | WITHDRAWN | B | 1,765 |
| | | | TOTAL | 105,745 |

Table A-1: Permits- Pontchartrain Basin (Basin 1)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | WATER MGT | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| St Bernard Ph w/l 33 | St. Bernard Ph | 81 | 81-01-21 | 1 | B/S | 3,080 | 3080 | WF,MR | YES | p,E | 3080 | 3080 | A | |
| | | 82 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| Lake Borgne Canal 5 | St. Bernard Ph | 83 | 83-10-03 | 1 | B | 2,762 | 2762 | WF,MR | NO | p,E | 2762 | 2762 | A | |
| Lake Borgne Canal 6 | St. Bernard Ph | 84 | 84-07-03 | 1 | B | 4,200 | 4200 | WF,MR | NO | C | 4200 | 4200 | A | |
| | | 85 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 86 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| St Bernard Ph w/l 69 | Biloxi Marsh Lands | 87 | 87-04-16 | 1 | S | 834 | 834 | WF | NO | p,NE | 834 | 834 | A | |
| St Charles Ph w/l 156A | St. Charles Land | 88 | 88-05-26 | 1 | I/B | 12,640 | 12640 | MR,WF | YES | C | 12640 | 12640 | A | |
| | | 89 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 90 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 91 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| | | 92 | | 1 | | 0 | 0 | | | | 0 | 0 | | |
| IWW-NO to Mobile 65 | Chefco | 93 | 93-04-05 | 1 | B | 13,974 | 13974 | WF | NO | See CWPP | 13974 | 13974 | A | |
| | | 94 | | 1 | | 0 | 0 | | | | | 0 | | |
| | | 95 | | | | | | | | | | | | |
| | | | | SUMS | | 37490 | 37490 | | | | 37490 | 37490 | | |
| 6,248 | Avg Acs/permitted plan | 6,248 | Avg Acs/implemented plan | | | N=6 | N=6 | | | | N=6 | | | |

Table A-2: Permits- Breton Basin (Basin 2)
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| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | WATER MGT | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 81 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| Plaq Ph w/l 282 | Delacroix Corp | 82 | 82-10-01 | 2 | B | 2,260 | 2260 | WF,MR | NO | p,E | 2260 | 2260 | A | |
| St Bernard Ph w/l 48 | St. Bernard Ph | 83 | 83-05-13 | 2 | B | 3,080 | 11312 | WF,MR | NO | p,E | 3080 | 11312 | A | |
| Caernarvon Canal 1 | St. Bernard Ph | | 83-09-30 | 2 | B | 2,960 | | WF,MR | NO | p,E | 2960 | | A | |
| Bayou Mandeville 2 | St. Bernard Ph | | 83-09-30 | 2 | B | 5,272 | | WF,MR | NO | p,E | 5272 | | A | |
| | | 84 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 85 | | 2 | | | | | | | 0 | 0 | | |
| | | 86 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 87 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 88 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 89 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 90 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 91 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 92 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 93 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 94 | | 2 | | 0 | 0 | | | | 0 | 0 | | |
| | | 95 | | | | | | | | | | | | |
| | | | | SUMS | | 13,572 | 13,572 | | | | 13,572 | 13,572 | | |

3,393 Avg Acs/permitted plan 3,393 Avg Acs/implemented plan

N=4 (ADJUSTE ACS ADD)

N=4 (APPLIED ACRES) N=4 (PRMTTD ACRES)

Table A-3: Permits- Barataria Basin (Basin 4)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | WATER MGT | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | N=4 | N=4 | | | | | | | |
| | | 77 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| Barataria B WW 226 | James Webb Est. | 81 | 81-09-25 | 4 | B | 1,190 | 1190 | WF,MR | NO | c | 1190 | 1190 | P | |
| | | 82 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| Lafourche Ph w/l 480 | Louis Cheramie | 83 | 83-04-27 | 4 | B/S | 2,950 | 2950 | MR | YES | c | 2950 | 2950 | A | Partially abandoned |
| Lafourche Ph w/l 547 | LL&E | 84 | 84-10-19 | 4 | B/S | 3,573 | 61530 | WF,MR | NO | p,E | 3573 | 61530 | A | |
| Lafourche Ph w/l 517 | Lafourche Realty | | 84-10-05 | 4 | S | 12,300 | | WF,MR | YES | C | 12300 | | A | |
| Lafourche Ph w/l 540 | LA. Delta Farms | | 84-11-02 | 4 | F/I/B | 45,657 | | WF | YES | p,NE | 45657 | | A | |
| Lafourche Ph w/l 529 | LL&E | 85 | 85-07-31 | 4 | B | 6,666 | 22020 | WF,MR | NO | p,E | 6666 | 22020 | P | |
| Lafourche Ph w/l 577 | Harrison & Ryan | | 85-07-31 | 4 | B/S | 8,700 | | WF,MR | NO | p,E | 8700 | | A | |
| Lafourche Ph w/l 527 | Sea Farms (Cheramie) | | 85-07-31 | 4 | S | | | MA | | Withdrawn | 0 | | | |
| Byou Des Allemands 110 | LL&E | | 85-11-04 | 4 | F | 5,976 | | MR | NO | p,E | 5976 | | P | |
| Byou Des Allemands 107 | Whitney Bank | | 85-09-04 | 4 | F | 678 | | RE | NO | C | 678 | | A | Same as Laf P wl 773 |
| | | 86 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 87 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 88 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| Jeff. Ph w/l 192 | Little Lake Hunting | 89 | 89-06-21 | 4 | B | 450 | 450 | WF,MR | YES | c | 450 | 450 | A | |
| Jefferson Ph w/l 215 | Jean Lafitte Park | 90 | 90-06-29 | 4 | I | 12,400 | 12400 | WF,MR | | p,NE | 12400 | 12400 | A | |
| Lafourche Ph w/l 733 | Gheens Foundation | 91 | 91-07-12 | 4 | F | 5,385 | 128525 | WF | NO | C | 5385 | 128525 | A | Partly same as Bayou des Allemands 107 |
| Jeff. Ph w/l 229 | US FWS | | 91-07-31 | 4 | B | 140 | | RE | NO | C | 140 | | A | |
| Lafourche Ph w/l 743 | Lafourche Parish | | 91-12-04 | 4 | F/I/B | 123,000 | | MR | YES | P,NE | 123000 | | P | |
| | | 92 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| | | 93 | | 4 | | 0 | 0 | | | | 0 | 0 | | |
| Lafourche Ph w/l 718 | Plaisance | 94 | 94-05-18 | 4 | | 6,250 | 6250 | MR | NO | P,NE | 6250 | 6250 | P | |
| Jefferson Ph w/l 260 | USDA-SCS | | Pending | 4 | I/B | 7,199 | 0 | x | x | Pending | 0 | 0 | P | |
| | | 95 | | | | | | | | | | | | |
| | | | | SUMS | | 242,514 | 235,315 | | | | 235315 | 235315 | | |
| | | | | | | N=17 | N=15 | | | | N=15 | | | |

13,842 Avg Acs/permitted plan 15,688 Avg Acs/implemented plan

Table A-4:Terrebonne Basin (Basin 5)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| | | 81 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| Terrebonne Ph w/l 478 | Leonard Chabert | 82 | 82-09-07 | 5 | I | 456 | 456 | MR,WF | YES | C | 456 | 456 | A | |
| Terrebonne Ph w/l 496 | Terrebonne Land | | 82-06-30 | 5 | I/B | 325 | | WF,MA | NO | nw,E | 0 | | | |
| Terrebonne Ph w/l 628 | Continental L & F | 83 | 83-12-21 | 5 | F | 3,350 | 3350 | MR,WF | NO | p,E | 3350 | 3350 | A | |
| Terrebonne Ph w/l 625 | Continental L & F | 84 | 84-02-06 | 5 | F | 5,282 | 12504 | MR | YES | p,NE | 5282 | 12504 | P | |
| Terrebonne Ph w/l 696 | Tenneco, Inc | | 84-10-10 | 5 | I/B | 7,222 | | MR,WF | YES | C | 7222 | | A | |
| St Mary Ph w/l 146 | Avoca, Inc | 85 | 85-08-07 | 5 | F | 800 | 800 | WF,MR | NO | C | 800 | 800 | A | |
| | | 86 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| St Louis Canal 7 | Terrebonne Aquacult | 87 | 87-08-27 | 5 | F | 45 | 2461 | WF,MA | NO | nw,E | 0 | 0 | | |
| Lafourche Ph w/l 637 | Harold Folse | | 87-10-02 | 5 | F | 2,416 | | WF | NO | nw,E | 0 | | | |
| Terrebonne Ph w/l 822 | Harry Bourg Corp | 88 | 88-06-22 | 5 | B | 1,152 | 1152 | MR,WF | NO | nw,E | 0 | 0 | | |
| Falgout Canal 2 | Terr. Ph. Govt | 89 | 89-03-03 | 5 | I/B | 8,000 | 10555 | MR | YES | C | 8000 | 10555 | A | |
| Terrebonne Ph w/l 870 | Wylie Heirs | | 89-08-30 | 5 | F | 2,555 | | MR,WF | YES | p,E | 2555 | | A | |
| Lafourche Ph w/l 703 | Intracoastal Oilfield | 90 | 90-03-30 | 5 | CT/F | 644 | 2544 | WF | NO | C | 644 | 644 | A | |
| Terrebonne Ph w/l 930 | Leonard Chabert | | 90-08-03 | 5 | F/I | 1,900 | | WF,MR | NO | nw,E | 0 | | | Basis for Terr P W/L 943 |
| Byou LaLoutre 83 | US FWS | 91 | 91-06-24 | 5 | B | 340 | 7440 | RE | NO | C | 340 | 7440 | A | FWS Research |
| Terrebonne Ph w/l 943 | Leonard Chabert | | 91-09-23 | 5 | F/I | 4,100 | | WF,MR | NO | p,E | 4100 | | A | 2,200 new acres & 1,900 acres from Terrebonne Parish w/l 930 |
| Terrebonne Ph w/l 953 | So. Terr. Tidewater | | 91-11-20 | 5 | B | 3,000 | | MR | YES | p,NE | 3000 | | P | |
| | | 92 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| | | 93 | | 5 | | 0 | 0 | | | | 0 | 0 | | |
| Terrebonne Ph w/l 991 | So. Terr Tidewater | 94 | 94-05-12 | 5 | B | 4,374 | 5274 | MR | NO | p,NE | 4374 | 5274 | A | |
| Grand Bayou 169 | LaPlante & Naquin | | 94-07-21 | 5 | | 900 | | WF | NO | p,NE | 900 | | A | |
| Lafourche Ph w/l 675a | Naquin | 95 | 95-03-17 | 5 | F/I | 950 | 1125 | WF,MR | | p | 1125 | 1125 | A | |
| Terrebonne Ph w/l 1043 | NMFS | | Pending | 5 | B/S | 4,200 | 0 | MR | | | 0 | | P | |
| Terrebone Ph w/l 1044 | NMFS | | Pending | 5 | B/S | 804 | 0 | MR | | | 0 | | P | |
| | | | | SUMS | | 52,815<br>N=21 | 47,661<br>N=19 | | | | 42,148<br>N=14 | 42,148 | | |

2,508 Avg Acs/permitted plan 3,011 Avg Acs/implemented plan

Table A-6: Atchafalya Basin (Basin 6)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 78 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 79 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 80 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 81 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 82 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 83 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 84 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 85 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 86 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 87 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 88 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 89 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 90 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 91 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 92 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 93 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 94 | | 6 | | 0 | 0 | | | | 0 | 0 | |
| | | 95 | | 6 | | 0 | 0 | | | | | | |
| | | | | SUMS | | 0 | 0 | | | | 0 | 0 | |

0 Avg Acs/permitted plan Avg Acs/implemented plan

Table A-7: Teche-Vermilion Basin (Basin 7)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| Vermilion Ph w/l 138 | Isidore Delcambre | 81 | 81-10-30 | 7 | B | 1,200 | 1200 | MR,FB | NO | C | 1200 | 1200 | A | Reacquire mgt. capability |
| | | 82 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| Vermilion Ph w/l 151 | Vermilion School Brd | 83 | 83-01-07 | 7 | F/I | 640 | 6023 | WF | NO | C | 640 | 5890 | A | Reacquire/improve mgt. capability |
| LTAV 181-A | Prior Exploration | | 83-02-25 | 7 | I/B | 750 | | MR,WF | NO | p,E | 750 | | P | Mitigation (incomplete); reacquire/imporve mgt. capability |
| Iberia Ph w/l 84 | Mcilhenny Co. | | 83-05-04 | 7 | F/I | 4,500 | | MR,WF/FB | NO | C | 4500 | | P | Acquire mgt. capability |
| St Mary Ph w/l 115 | Stone Petroleum | | 83-06-21 | 7 | F | 133 | | WF | NO | nw,E | 0 | | A | Acquire mgt. capability |
| | | 84 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| | | 85 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| Freshwater Bayou 27 | Vermilion Corp | 86 | 86-03-06 | 7 | I | 3,900 | 9440 | WF,MR | NO | p,E | 3900 | 9440 | A | Acquire mgt. capability |
| Vermilion Ph w/l 221 | Donald Caldwell | | 86-09-29 | 7 | B | 690 | | MR,WF | NO | p,E | 690 | | A | Acquire mgt. capability |
| St Mary Ph w/l 153 | Miami Corp | | 86-10-20 | 7 | F | 3,085 | | MR,WF | NO | p,NE | 3085 | | P | Reacquire/expand mgt. capability |
| Vermilion Ph w/l 239 | Mike Pettit | | 86-12-01 | 7 | B | 1,765 | | MR,WF | NO | p,E | 1765 | | A | Upgrade/expand mgt. capability |
| Vermilion Ph w/l 236 | Vermilion Bay Land | 87 | 87-03-31 | 7 | B | 1,035 | 1035 | MR,WF | YES | C | 1035 | 1035 | A | Acquire greater mgt capability, expansion of LTAV 181a |
| | | 88 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| Bayou Cassmer 1 | Cashco Oil | 89 | 89-04-19 | 7 | B | 1,100 | 1100 | MR,FB/WF | NO | p,e | 1100 | 1100 | P | Mitigation; acquire mgt. capability |
| | | 90 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| | | 91 | | 7 | | 0 | 0 | | | | 0 | 0 | | |
| Vermilion Ph w/l 272 | Leslie Godchaux | 92 | 92-08-04 | 7 | I/B | 6,570 | 6570 | MR,WF | NO | p,ne | 6570 | 6570 | A | Reacquire/expand mgt. capability |
| | | 93 | | 7 | | 0 | 0 | | | | 0 | | | |
| | | 94 | | 7 | | 0 | 0 | | | | 0 | | | |
| | | 95 | | | | 0 | 0 | | | | 0 | 0 | | |
| | | | | SUMS | | 25,368 | 25,368 | | | | 25,235 | 25,235 | | |

2,114 Avg Acs/permitted plan    2,294 Avg Acs/implemented plan    N=11

Table A-8: Mermentau Basin (Basin 8)

| PERMIT NUMBER | APPLICANT | CALEND YEAR | PERMIT DATE | HYDRO UNIT | MARS TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | WATER MGT | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | N=12 | N=12 | | | | | | | |
| Little Pecan Bayou 5 | Little Pecan Prop. | 77 | 77-05-12 | 8 | I/B | 5,000 | 5000 | WF/FB | YES | C | 5000 | 5000 | A | Upgrade/expand mgt. capability |
| | | 78 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| | | 80 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| | | 81 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| LTVM 94 1/2 | Lake Arthur Recl | 82 | 82-08-19 | 8 | F | 2,800 | 6500 | WF | NO | C | 0 | 3700 | P | Outside study area |
| Schooner Bayou 7 | Verm Ph Pol Jur | | 82-08-24 | 8 | I/B | 3,700 | | MR,WF | YES | p,E | 3700 | | A | 4 of 6 installed for saltwater intrusion |
| North Bayou 1 | Superior Oil | 83 | 83-01-17 | 8 | B | 4,100 | 8100 | MR | NO | c,E | 4100 | 8100 | P | |
| Mermentau River 151 | Cameron Pol. Jur. | | 83-07-15 | 8 | B | 4,000 | | MR | NO | C | 4000 | | A | Maintain mgt. capability |
| Creole Canal 2 | Cam. Ph GDD 4 | 84 | 84-05-25 | 8 | I | 3,264 | 10462 | MR | NO | C | 3264 | 10462 | P | Acquire mgt. capability |
| Vermilion Ph w/I 200 | Vermilion Corp | | 84-09-26 | 8 | B | 3,378 | | MR,WF | NO | p,E | 3378 | | A | Acquire additional mgt. capability, semi-impoundment |
| Vermilion Ph w/I 197 | Vermilion Corp | | 84-10-12 | 8 | F/I | 3,820 | | WF,MR | NO | C | 3820 | | A | |
| Vermilion Ph w/I 220 | Vermilion Corp | 85 | 85-10-25 | 8 | I | 2,260 | 2939 | MR,WF | NO | p,E | 2260 | 2939 | A | Acquire mgt. capability, semi-impoundment |
| Cameron Ph w/I 710 | Benny Welch | | 85-10-28 | 8 | F | 279 | | WF | NO | C | 279 | | P | Reacquire mgt. capability; within area affected by Mermentau River 151 |
| Cameron Ph w/I 770 | Brian Domingue | 86 | 86-05-19 | 8 | F/I | 400 | | WF | YES | C | 400 | | A | Reacquire mgt. capability of previously leveed area |
| | | 87 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| Cameron Ph w/I 839 | Cam. Ph GDD 5 | 88 | 88-05-11 | 8 | F/I | 960 | 960 | MR,WF | NO | p,e | 960 | 960 | A | Reacquire integrity against saltwater intrusion |
| Vermilion Ph w/I 252 | Vermilion Corp | 89 | 89-09-12 | 8 | F/I/B | 10,396 | 10396 | MR,WF | NO | p,ne | 6296 | 6296 | A | Upgrade/expand mgt. capability; extension from 4100 acres from North Bayou 1 |
| Cameron Ph w/I 887 | Henry Mayer | 90 | 90-05-24 | 8 | B | 1,419 | 8574 | WF | NO | p,ne | 1419 | 8574 | A | |
| Vermilion Ph w/I 260 | Semmes Lynch | | 90-04-26 | 8 | B | 405 | | WF,MR | NO | C | 405 | | A | Reacquire/upgrade mgt. capability |
| Cameron Ph w/I 906 | Miami Corp | | 90-10-29 | 8 | F/I | 6,750 | | MR | YES | C | 6750 | | A | Acquire mgt. capability |
| Vermilion Ph w/I 285 | Vermilion Corp | 91 | 91-06-17 | 8 | F | 30,000 | 30800 | MR | YES | C | 0 | 0 | | Large-scale fresh water diversion |
| Cameron Ph w/I 912 | John John | | 91-09-26 | 8 | F/I | 800 | | WF/FB | NO | nw,E | 0 | | | Reacquire/upgrade mgt. capability |
| | | 92 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| | | 93 | | 8 | | 0 | 0 | | | | 0 | 0 | | |
| CameronPh w/I 1021 | Coastal Club | 94 | 94-12-21 | 8 | F | 850 | 850 | WF/FB | NO | Issued | 0 | 0 | A | Outside study area; reacquire/upgrade mgt. capability |
| Cameron Ph w/I 1014 | Miami Corp. | 95 | 95 | 8 | F/I/B | 2,700 | 2700 | MR | NO | Issued | 0 | 0 | A | CWPPRA's PME-14; contained |
| Vermilion Ph w/I 1321 | Verm Corp. | | Pending | 8 | I | 36,000 | | MR | NO | N/A | 0 | | | within boundaries of Little Pecan Bayou 5 |
| | | | | SUMS | | 123,281 | 87,281 | | | | 46,031 | 46,031 | | |
| | | | | | | N=22 | N=20 | | | | N = 15 | | | |

4,114 Avg Acs/permitted plan

3,069 Avg Acs/implemented plan

Table A-9: Calcasieu-Sabine Basin (Basin 9)

| PERMIT NUMBER | APPLICANT | CALENDA YEAR | PERMIT DATE | HYDRO UNIT | MARSH TYPE | APPLIED ACRES | PRMTTD ACRES | PURPOSE | MODIFIED | STATUS | ADJUSTE ACS ADD | SUM ADJ. ACS/YR | WATER MGT | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 77 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| | | 78 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| | | 79 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| Calcasieu Lake 382 | Cam. Ph GDD 3 | 80 | 80-10-16 | 9 | I/B/S | 66,000 | 66000 | MR | YES | p,E | 66000 | 66000 | A | |
| | | 81 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| Black Lake 30 | Amoco (Derouen) | 82 | 82-08-16 | 9 | F/I | 768 | 768 | WF | NO | c | 768 | 768 | A | |
| Oyster Bayou 7 | Wm T Burton Indust | 83 | 83-08-10 | 9 | B | 1,850 | 1850 | MR,WF | NO | C | 1850 | 1850 | A | Reacquire/upgrade mgt. capability against saltwater intrusion |
| Cameron Ph w/I 611 | James & JB Constance | 84 | 84-06-19 | 9 | B | 35 | 35 | MA | NO | p,E | 35 | 35 | A | |
| | | 85 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| Cameron Ph w/I 744 | Amoco | 86 | 86-05-15 | 9 | F/I | 6,620 | 6620 | WF | YES | c | 6620 | 6620 | A | |
| | | 87 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| | | 88 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| | | 89 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| LTMC 59 | Miami Corp | 90 | 90-05-04 | 9 | F | 0 | 0 | MR/WF | YES | C | 0 | 0 | A | Abuts basin boundary |
| Cameron Ph w/I 863 | T. Shaughnessy | 91 | 91-01-16 | 9 | B | 800 | 8922 | WF | NO | C | 800 | 2173 | A | |
| #19231 | Lawton & Gum Cove | | 91-05-20 | 9 | I/B | 6749 | | MR/WF | NO | p | 0 | | | Abuts but north of basin boundary; Galveston Dist COE |
| Cameron Ph w/I 832 | Amoco (Murphy) | | 91-10-11 | 9 | F/I | 1,373 | | WF/MR | NO | p,e | 1373 | | A | |
| Cameron Ph w/I 923 | Fina | 92 | 92-03-26 | 9 | B/S | 7,224 | 14620 | MR/WF | YES | nw,NE | 7224 | 13834 | A | |
| Cameron Ph w/I 831 | Amoco (Duhon) | | 92-07-23 | 9 | B | 786 | | MR/WF | NO | nw,E | 0 | | | |
| Cameron Ph w/I 963 | Cameron GDD 9 | | 92-07-31 | 9 | F/I | 6,575 | | MR/WF | NO | p,NE | 6575 | | A | |
| Calcasieu Ph w/I 67 | B. Watts | | 92-08-18 | 9 | I/B | 35 | | WF | YES | C | 35 | | A | |
| | | 93 | | 9 | | 0 | 0 | | | | 0 | 0 | | |
| Cameron Ph w/I 987 | Amoco | 94 | Pending | 9 | ? | 2,794 | 0 | ? | | N/A | 0 | 0 | | |
| #20051 | Cam. Ph GDD 7 | 95 | 95-04-06 | 9 | I/B | 1,200 | 1200 | MR | NO | NW | 1200 | 1200 | | Estimated acreage |

7,144 Avg Acs/permitted plan     8,407 Avg Acs/implemented plan

| | APPLIED ACRES | PRMTTD ACRES | ADJUSTE ACS ADD | SUM ADJ. ACS/YR |
|---|---|---|---|---|
| SUMS | 102,809 N=14 | 100,015 N=13 | 92,480 N=11 | 92,480 |

Table A-10: Permits- Purpose by Year (Summary)

| | WF | WF/MR | MR | RE | Other | Totals | Cumm WF | Cumm WF/MR | Cumm MR | Cumm RE | Cumm Other | Cumm Totals | Avg | N | Cumm N | Cumm Avg | Cumm Tot/ 10000 | Avg Acres per Permit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | 5000 | 0 | 0 | 0 | 0 | 5000 | 5000 | | | | | 5000 | 5000 | 1 | 1 | 5000 | 0.5 | 5000 |
| 78 | 0 | 0 | 0 | 0 | 0 | 0 | 5000 | | | | | 5000 | 0 | 0 | 1 | 5000 | 0.5 | 0 |
| 79 | 0 | 0 | 0 | 0 | 0 | 0 | 5000 | | | | | 5000 | 0 | 0 | 1 | 5000 | 0.5 | 0 |
| 80 | 0 | 0 | 66000 | 0 | 0 | 66000 | 5000 | | 66000 | | | 71000 | 66000 | 1 | 2 | 35500 | 7.1 | 66000 |
| 81 | 0 | 5470 | 0 | 0 | 0 | 5470 | 5000 | 5470 | 66000 | | | 76470 | 1823 | 3 | 5 | 15294 | 7.6 | 1823 |
| 82 | 768 | 6416 | 0 | 0 | 0 | 7184 | 5768 | 11886 | 66000 | | | 83654 | 1796 | 4 | 9 | 9295 | 8.4 | 1796 |
| 83 | 640 | 24524 | 11050 | 0 | 0 | 36214 | 6408 | 36410 | 77050 | | | 119868 | 3018 | 12 | 21 | 5708 | 12.0 | 3018 |
| 84 | 45657 | 34493 | 8546 | 0 | 35 | 88731 | 52065 | 70903 | 85596 | | 35 | 208599 | 8873 | 10 | 31 | 6729 | 20.9 | 8873 |
| 85 | 279 | 18426 | 5976 | 678 | 0 | 25359 | 52344 | 89329 | 91572 | 678 | 35 | 233958 | 3623 | 7 | 38 | 6157 | 23.4 | 3623 |
| 86 | 7020 | 9440 | 0 | 0 | 0 | 16460 | 59364 | 98769 | 91572 | 678 | 35 | 250418 | 2743 | 6 | 44 | 5691 | 25.0 | 2743 |
| 87 | 834 | 1035 | 0 | 0 | 0 | 1869 | 60198 | 99804 | 91572 | 678 | 35 | 252287 | 935 | 2 | 46 | 5485 | 25.2 | 935 |
| 88 | 0 | 13600 | 0 | 0 | 0 | 13600 | 60198 | 113404 | 91572 | 678 | 35 | 265887 | 6800 | 2 | 48 | 5539 | 26.6 | 6800 |
| 89 | 0 | 10401 | 8000 | 0 | 0 | 18401 | 60198 | 123805 | 99572 | 678 | 35 | 284288 | 3680 | 5 | 53 | 5364 | 28.4 | 3680 |
| 90 | 2063 | 12805 | 6750 | 0 | 0 | 21618 | 62261 | 136610 | 106322 | 678 | 35 | 305906 | 4324 | 5 | 58 | 5274 | 30.6 | 4324 |
| 91 | 6185 | 5473 | 126000 | 480 | 0 | 138138 | 68446 | 142083 | 232322 | 1158 | 35 | 444044 | 17267 | 8 | 66 | 6728 | 44.4 | 17267 |
| 92 | 35 | 20369 | 0 | 0 | 0 | 20404 | 68481 | 162452 | 232322 | 1158 | 35 | 464448 | 5101 | 4 | 70 | 6635 | 46.4 | 5101 |
| 93 | 13974 | 0 | 0 | 0 | 0 | 13974 | 82455 | 162452 | 232322 | 1158 | 35 | 478422 | 13974 | 1 | 71 | 6738 | 47.8 | 13974 |
| 94 | 900 | 0 | 10624 | 0 | 0 | 11524 | 83355 | 162452 | 242946 | 1158 | 35 | 489946 | 3841 | 3 | 74 | 6621 | 49.0 | 3841 |
| 95 | 0 | 1125 | 1200 | 0 | 0 | 2325 | 83355 | 163577 | 244146 | 1158 | 35 | 492271 | 1163 | 2 | 76 | 6477 | 49.2 | 1163 |
| Totals | 83355 | 163577 | 244146 | 1158 | 35 | 492271 | | | | | | | | | | | | 6477 |
| | | | | | | 492271 | | | | | | | | | | | | |

Table A-11: Permits- Basin by Year (Summary)

| | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | Delta | Cumm Delta | Chenier | Cumm Chenier | Year Totals | Cumm Totals | Year Avgs | Year N | Cumm N | Cumm Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | | | 5000 | | | 0 | 5000 | 5000 | 5000 | 5000 | 5000 | 1 | 1 | 5000 |
| 78 | | | | | | | | | | 0 | | 5000 | 0 | 5000 | 0 | 0 | 1 | 5000 |
| 79 | | | | | | | | | | 0 | | 5000 | 0 | 5000 | 0 | 0 | 1 | 5000 |
| 80 | | | | | | | | 66000 | | 0 | 66000 | 71000 | 66000 | 71000 | 66000 | 1 | 2 | 35500 |
| 81 | 3080 | | 1190 | | | 1200 | | | 5470 | 5470 | | 71000 | 5470 | 76470 | 1823 | 3 | 5 | 15294 |
| 82 | | 2260 | | 456 | | | 3700 | 768 | 2716 | 8186 | 4468 | 75468 | 7184 | 83654 | 1796 | 4 | 9 | 9295 |
| 83 | 2762 | 11312 | 2950 | 3350 | | 5890 | 8100 | 1850 | 26264 | 34450 | 9950 | 85418 | 36214 | 119868 | 3018 | 12 | 21 | 5708 |
| 84 | 4200 | | 61530 | 12504 | | | 10462 | 35 | 78234 | 112684 | 10497 | 95915 | 88731 | 208599 | 8873 | 10 | 31 | 6729 |
| 85 | | | 22020 | 800 | | | 2939 | | 22820 | 135504 | 2939 | 98854 | 25759 | 234358 | 3680 | 7 | 38 | 6167 |
| 86 | | | | | | 9440 | | 6620 | 9440 | 144944 | 6620 | 105474 | 16060 | 250418 | 2677 | 6 | 44 | 5691 |
| 87 | 834 | | | | | 1035 | | | 1869 | 146813 | | 105474 | 1869 | 252287 | 935 | 2 | 46 | 5485 |
| 88 | 12640 | | | | | | 960 | | 12640 | 159453 | 960 | 106434 | 13600 | 265887 | 6800 | 2 | 48 | 5539 |
| 89 | | | 450 | 10555 | | 1100 | 6296 | | 12105 | 171558 | 6296 | 112730 | 18401 | 284288 | 3680 | 5 | 53 | 5364 |
| 90 | | | 12400 | 644 | | | 8574 | | 13044 | 184602 | 8574 | 121304 | 21618 | 305906 | 4324 | 5 | 58 | 5274 |
| 91 | | | 128525 | 7440 | | | | 2173 | 135965 | 320567 | 2173 | 123477 | 138138 | 444044 | 17267 | 8 | 66 | 6728 |
| 92 | | | | | | 6570 | | 13834 | 6570 | 327137 | 13834 | 137311 | 20404 | 464448 | 5101 | 4 | 70 | 6635 |
| 93 | 13974 | | | | | | | | 13974 | 341111 | 0 | 137311 | 13974 | 478422 | 13974 | 1 | 71 | 6738 |
| 94 | | | 6250 | 5274 | | | | | 11524 | 352635 | 0 | 137311 | 11524 | 489946 | 3841 | 3 | 74 | 6621 |
| 95 | | | | 1125 | | | | 1200 | 1125 | 353760 | 1200 | 138511 | 2325 | 492271 | 1163 | 2 | 76 | 6477 |
| Totals | 37490 | 13572 | 235315 | 42148 | 0 | 25235 | 46031 | 92480 | 353760 | | 138511 | | 492271 | | | | | |
| | | | | | | | | | Delta | | Chenier | | Total | | | | | |

Table A-12: Permits- Basin by Purpose (Summary)

| | Basin 1 | Basin 2 | Basin 4 | Basin 5 | Basin 6 | Basin 7 | Basin 8 | Basin 9 | Totals |
|---|---|---|---|---|---|---|---|---|---|
| WF | 14808 | | 51042 | 1544 | | 640 | 7098 | 8223 | 83355 |
| MR | | | 138176 | 20656 | | | 18114 | 67200 | 244146 |
| WF/MR | 22682 | 13572 | 45279 | 19608 | | 24595 | 20819 | 17022 | 163577 |
| RE | | | 818 | 340 | | | | 0 | 1158 |
| Other | | | | | | | | 35 | 35 |
| TOTAL | 37490 | 13572 | 235315 | 42148 | | 25235 | 46031 | 92480 | 492271 |

Table A-13: Permits- Included Marsh Type by Year (Summary)

| | F | F/I | I | F/I/B | I/B | B | B/S | I/B/S | S | U | Totals | Averages | Cumm Totals | N | Cumm N | Cumm Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 | | | | | 5000 | | | | | | 5000 | 5000 | 5000 | 1 | 1 | 5000 |
| 78 | | | | | | | | | | | 0 | 0 | 5000 | 0 | 1 | 5000 |
| 79 | | | | | | | | | | | 0 | 0 | 5000 | 0 | 1 | 5000 |
| 80 | | | | | | | | 66000 | | | 66000 | 66000 | 71000 | 1 | 2 | 35500 |
| 81 | | | | | | 2390 | 3080 | | | | 5470 | 1823 | 76470 | 3 | 5 | 15294 |
| 82 | | 768 | 456 | | 3700 | 2260 | | | | | 7184 | 1437 | 83654 | 4 | 9 | 9295 |
| 83 | 3350 | 5140 | | | 750 | 24024 | 2950 | | | | 36214 | 2786 | 119868 | 12 | 21 | 5708 |
| 84 | 5282 | 3820 | 3264 | 45657 | 7222 | 7613 | 3573 | | 12300 | | 88731 | 9859 | 208599 | 10 | 31 | 6729 |
| 85 | 7733 | | 2260 | | | 6666 | 8700 | | | | 25359 | 2536 | 233958 | 7 | 38 | 6157 |
| 86 | 3085 | 7020 | 3900 | | | 2455 | | | | | 16460 | 2351 | 250418 | 6 | 44 | 5691 |
| 87 | | | | | | 1035 | | | 834 | | 1869 | 467 | 252287 | 2 | 46 | 5485 |
| 88 | | 960 | | | 12640 | | | | | | 13600 | 4533 | 265887 | 2 | 48 | 5539 |
| 89 | 2555 | 0 | | 6296 | 8000 | 1550 | | | | | 18401 | 3680 | 284288 | 5 | 53 | 5364 |
| 90 | 644 | 6750 | 12400 | | | 1824 | | | | | 21618 | 3603 | 305906 | 5 | 58 | 5274 |
| 91 | 5385 | 5473 | | 123000 | | 4280 | | | | | 138138 | 13814 | 444044 | 8 | 66 | 6728 |
| 92 | | 6575 | | | 6605 | | 7224 | | | | 20404 | 4081 | 464448 | 4 | 70 | 6635 |
| 93 | | 0 | | | | 13974 | | | | | 13974 | 13974 | 478422 | 1 | 71 | 6738 |
| 94 | | 0 | | | | 4374 | | | | 7150 | 11524 | 3841 | 489946 | 3 | 74 | 6621 |
| 95 | | 1125 | | | 1200 | | | | | | 2325 | 1163 | 492271 | 2 | 76 | 6477 |
| Totals | 28034 | 37631 | 22280 | 174953 | 45117 | 72445 | 25527 | 66000 | 13134 | 7150 | 492271 | 5724 | | | | |
| Averages | 2803 | 3136 | 4456 | 58318 | 5640 | 2786 | 5105 | 66000 | 6567 | 7150 | | 7720 | | | | |

Table A-14: Permits- Basin by Included Marsh Type (Summary)

| | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | Delta Tot | Chenier Tot | Coast Tot | Delta Avg | Chenier Avg | Coast Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| F | | | 12039 | 12631 | | 3085 | 279 | | 27755 | 279 | 28034 | 3084 | 279 | 2803 |
| F/I | | | | 5225 | | 5140 | 11930 | 15336 | 10365 | 27266 | 37631 | 2591 | 3408 | 3136 |
| I | | | 12400 | 456 | | 3900 | 5524 | | 16756 | 5524 | 22280 | 5585 | 2762 | 4456 |
| F/I/B | | | 168657 | | | | 6296 | | 168657 | 6296 | 174953 | 84329 | 6296 | 58318 |
| I/B | 12640 | | | 15222 | | 7320 | 8700 | 1235 | 35182 | 9935 | 45117 | 7036 | 2484 | 5013 |
| B | 20936 | 13572 | 8446 | 7714 | | 5790 | 13302 | 2685 | 56458 | 15987 | 72445 | 2971 | 3997 | 2683 |
| I/B/S | | | | | | | | 66000 | | 66000 | 66000 | 0 | 8250 | 66000 |
| B/S | 3080 | | 15223 | | | | | 7224 | 18303 | 7224 | 25527 | 4576 | 7224 | 5105 |
| S | 834 | | 12300 | | | | | | 13134 | | 13134 | 6567 | 0 | 6567 |
| Unknown | | | 6250 | 900 | | | | | 7150 | | 7150 | 3575 | 0 | 3575 |
| Totals | 37490 | 13572 | 235315 | 42148 | | 25235 | 46031 | 92480 | 353760 | 138511 | 492271 | | | |
| | | | | | | 353760 | | 138511 | | | | | | |

Table A-15: Permits- Purpose by Included Marsh Type (Summary)

| | | | Purpose | | | CT | CT |
|---|---|---|---|---|---|---|---|
| Marsh Ty | WF | WF/MR | MR | Res | Other | Tots | Avgs |
| F | 6308 | 9790 | 11258 | 678 | | 28034 | 2803 |
| F/I | 8428 | 22453 | 6750 | | | 37631 | 3136 |
| I | 0 | 19016 | 3264 | | | 22280 | 4456 |
| F/I/B | 45657 | 6296 | 123000 | | | 174953 | 58318 |
| I/B | 5035 | 30882 | 15450 | | | 51367 | 5137 |
| B | 16193 | 40263 | 15474 | 480 | 35 | 72445 | 2683 |
| B/S | | 22577 | 2950 | | | 25527 | 5105 |
| I/B/S | | | 66000 | | | 66000 | 66000 |
| S | 834 | 12300 | | | | 13134 | 6567 |
| Unknown | 900 | | | | | 900 | 900 |
| Totals | 83355 | 163577 | 244146 | 1158 | 35 | 492271 | |
| | | | | | | | |
| Why Avgs | 5954 | 3804 | 17439 | 386 | 18 | | |

Table A-16: Permits- Purpose by Year

| | | WF | WF/MR | MR | Res | Other | Totals |
|---|---|---|---|---|---|---|---|
| | 77 | 5000 | | | | | 5000 |
| | 78 | | | | | | 0 |
| | 79 | | | | | | 0 |
| | 80 | | | 66000 | | | 66000 |
| | 81 | | 1190 | | | | 5470 |
| | | | 1200 | | | | |
| | | | 3080 | | | | |
| | 82 | 768 | 456 | | | | 7184 |
| | | | 3700 | | | | |
| | | | 2260 | | | | |
| | 83 | 640 | 2762 | 2950 | | | 36214 |
| | | | 4500 | | | | |
| | | | 3350 | 4100 | | | |
| | | | 1850 | 4000 | | | |
| | | | 3080 | | | | |
| | | | 5272 | | | | |
| | | | 2960 | | | | |
| | | | 750 | | | | |
| | 84 | 45657 | 4200 | 5282 | | 35 | 88731 |
| | | | 3573 | 3264 | | | |
| | | | 12300 | | | | |
| | | | 7222 | | | | |
| | | | 3378 | | | | |
| | | | 3820 | | | | |
| | 85 | 279 | 2260 | 5976 | 678 | | 25359 |
| | | | 6666 | | | | |
| | | | 8700 | | | | |
| | | | 800 | | | | |
| | 86 | 400 | 3085 | | | | 16460 |
| | | 6620 | 690 | | | | |
| | | | 1765 | | | | |
| | | | 3900 | | | | |
| | 87 | 834 | 1035 | | | | 1869 |
| | 88 | | 12640 | | | | 13600 |
| | | | 960 | | | | |
| | 89 | | 450 | 8000 | | | 18401 |
| | | | 2555 | | | | |
| | | | 6296 | | | | |
| | | | 1100 | | | | |
| | 90 | 644 | 12400 | 6750 | | | 21618 |
| | | 1419 | 405 | | | | |
| | 91 | 5385 | 4100 | 123000 | 140 | | 138138 |
| | | 800 | 1373 | 3000 | 340 | | |
| | 92 | 35 | 6570 | | | | 20404 |
| | | | 7224 | | | | |
| | | | 6575 | | | | |
| | 93 | 13974 | | | | | 13974 |
| | 94 | 900 | | 6250 | | | 11524 |
| | | | | 4374 | | | |
| | 95 | | 1125 | 1200 | | | 2325 |
| Totals | | 83355 | 163577 | 244146 | 1158 | 35 | 492271 |
| Avg | | 5557 | 3804 | 17439 | 386 | 35 | 6564 |
| n | | 15 | 43 | 14 | 3 | 1 | 76 |

Table A-17: Permits- Included Marsh Type by Year

| | | F | F/I | I | F/I/B | I/B | B | B/S | I/B/S | S | U | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 77 | | | | | 5000 | | | | | | |
| | 78 | | | | | | | | | | | |
| | 79 | | | | | | | | | | | |
| | 80 | | | | | | | | 66000 | | | |
| | 81 | | | | | | 1190 | 3080 | | | | |
| | | | | | | | 1200 | | | | | |
| | 82 | | 768 | 456 | | | 2260 | | | | | |
| | | | | | | 3700 | | | | | | |
| | 83 | 3350 | 640 | | | 750 | 2762 | | | | | |
| | | | 4500 | | | | 3080 | 2950 | | | | |
| | | | | | | | 2960 | | | | | |
| | | | | | | | 1850 | | | | | |
| | | | | | | | 4100 | | | | | |
| | | | | | | | 4000 | | | | | |
| | | | | | | | 5272 | | | | | |
| | 84 | 5282 | 3820 | 3264 | 45657 | 7222 | 4200 | 3573 | | 12300 | | |
| | | | | | | | 35 | | | | | |
| | | | | | | | 3378 | | | | | |
| | 85 | 5976 | | 2260 | | | | | | | | |
| | | 800 | | | | | 6666 | 8700 | | | | |
| | | 279 | | | | | | | | | | |
| | | 678 | | | | | | | | | | |
| | 86 | | 400 | 3900 | | | 690 | | | | | |
| | | 3085 | 6620 | | | | 1765 | | | | | |
| | 87 | | | | | | 1035 | | | 834 | | |
| | 88 | | 960 | | | 12640 | | | | | | |
| | 89 | 2555 | | | 6296 | 8000 | 450 | | | | | |
| | | | | | | | 1100 | | | | | |
| | 90 | 644 | | 12400 | | | 405 | | | | | |
| | | | 6750 | | | | 1419 | | | | | |
| | 91 | 5385 | 4100 | | 123000 | | 140 | | | | | |
| | | | | | | | 340 | | | | | |
| | | | 1373 | | | | 3000 | | | | | |
| | | | | | | | 800 | | | | | |
| | 92 | | 6575 | | | 6570 | | 7224 | | | | |
| | | | | | | 35 | | | | | | |
| | 93 | | | | | | 13974 | | | | | |
| | 94 | | | | | | 4374 | | | | 6250 | |
| | | | | | | | | | | | 900 | |
| | 95 | | 1125 | | | 1200 | | | | | | |
| Totals | | 28034 | 37631 | 22280 | 174953 | 45117 | 72445 | 25527 | 66000 | 13134 | 7150 | 492271 |
| Average | | 2803 | 3136 | 4456 | 58318 | 6445 | 2786 | 5105 | 66000 | 6567 | 3575 | 6652 |
| n | | 10 | 12 | 5 | 3 | 9 | 27 | 5 | 1 | 2 | 2 | 76 |

Table A-18: Permits- Basin by Purpose

| | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | Purpose Totals |
|---|---|---|---|---|---|---|---|---|---|
| WF | 834 | | 45657 | 644 | | | 5000 | 768 | 83355 |
| | 13974 | | 5385 | 900 | | 640 | 1419 | 800 | |
| | | | | | | | 279 | 35 | |
| | | | | | | | 400 | 6620 | |
| MR | | | 5976 | 5282 | | | 4100 | 66000 | 244146 |
| | | | 2950 | 8000 | | | 4000 | 1200 | |
| | | | 123000 | 3000 | | | 3264 | | |
| | | | 6250 | 4374 | | | 6750 | | |
| WF/MR | 3080 | 3080 | 1190 | 456 | | 1200 | 3700 | 1850 | 163577 |
| | 4200 | 2960 | 3573 | 3350 | | 4500 | 3820 | 1373 | |
| | 12640 | 5272 | 12300 | 800 | | 690 | 3378 | 7224 | |
| | 2762 | 2260 | 6666 | 1125 | | 1765 | 2260 | 6575 | |
| | | | 8700 | 2555 | | 1035 | 960 | | |
| | | | 450 | | | 3900 | 6296 | | |
| | | | | | | 3085 | 405 | | |
| | | | | | | 1100 | | | |
| | | | | | | 6570 | | | |
| | | | 12400 | 4100 | | 750 | | | |
| | | | | 7222 | | | | | |
| RE | | | 140 | 340 | | | | | 1158 |
| | | | 678 | | | | | | |
| Other (WF/MA) | | | | | | | | 35 | 35 |
| Basin Tots | 37490 | 13572 | 235315 | 42148 | 0 | 25235 | 46031 | 92480 | 492271 |
| Region Tots | 353760 | Delta | | | | | 138511 | Chenier | |

Table A-19: Permits- Basin by Included Marsh Type

| | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | Delta Totals | Chenier Totals | Coast Totals |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F | | | 5976 | 3350 | | 3085 | | | 27755 | 279 | 28034 |
| | | | 678 | 5282 | | | 279 | | | | |
| | | | 5385 | 800 | | | | | | | |
| | | | | 644 | | | | | | | |
| | | | | 2555 | | | | | | | |
| F/I | | | | 4100 | | 640 | 3820 | 768 | 10365 | 27266 | 37631 |
| | | | | 1125 | | 4500 | 400 | 6620 | | | |
| | | | | | | | 960 | | | | |
| | | | | | | | 6750 | | | | |
| | | | | | | | | 1373 | | | |
| | | | | | | | | 6575 | | | |
| I | | | 12400 | 456 | | 3900 | 3264 | | 16756 | 5524 | 22280 |
| | | | | | | | 2260 | | | | |
| F/I/B | | | 45657 | | | | 6296 | | 168657 | 6296 | 174953 |
| | | | 123000 | | | | | | | | |
| I/B | 12640 | | | 7222 | | 6570 | 5000 | 35 | 35182 | 9935 | 45117 |
| | | | | 8000 | | 750 | 3700 | 1200 | | | |
| B | 2762 | 3080 | 1190 | 340 | | 1200 | 4100 | 1850 | 56458 | 15987 | 72445 |
| | 4200 | 2960 | 6666 | 3000 | | | 4000 | 35 | | | |
| | 13974 | 5272 | 450 | 4374 | | | 405 | 800 | | | |
| | | 2260 | 140 | | | 690 | | | | | |
| | | | | | | 1765 | 3378 | | | | |
| | | | | | | 1035 | 1419 | | | | |
| | | | | | | 1100 | | | | | |
| I/B/S | | | | | | | | 66000 | 0 | 66000 | 66000 |
| B/S | 3080 | | 2950 | | | | | 7224 | 18303 | 7224 | 25527 |
| | | | 3573 | | | | | | | | |
| | | | 8700 | | | | | | | | |
| S | 834 | | 12300 | | | | | | 13134 | 0 | 13134 |
| Unknown | | | 6250 | 900 | | | | | 7150 | 0 | 7150 |
| TOTALS | 37490 | 13572 | 235315 | 42148 | 0 | 25235 | 46031 | 92480 | 353760 | 138511 | 492271 |
| | | | | | | | | 492271 | | | |
| | | | | | | | | | | 492271 | |
| N | 6 | 4 | 15 | 14 | 0 | 11 | 15 | 11 | 50 | 26 | 76 |

Table A-20: Permits- Purpose by Included Marsh Type

| | WF | WF/MR | MR | Res | Other | TOTALS | Summary Im |
|---|---|---|---|---|---|---|---|
| F | | 3350 | 5976 | 678 | | 28034 | Marsh Type |
| | 644 | 800 | 5282 | | | | F |
| | 5385 | 3085 | | | | | F/I |
| | 279 | 2555 | | | | | I |
| | | | | | | | F/I/B |
| F/I | 640 | 4100 | 6750 | | | 37631 | I/B |
| | 400 | 3820 | | | | | B |
| | 6620 | 960 | | | | | B/S |
| | 768 | 4500 | | | | | I/B/S |
| | | 1125 | | | | | S |
| | | 1373 | | | | | Unknown |
| | | 6575 | | | | | Totals |
| I | | 12400 | 3264 | | | 22280 | |
| | | 456 | | | | | Why Avgs |
| | | 2260 | | | | | |
| | | 3900 | | | | | |
| F/I/B | 45657 | 6296 | 123000 | | | 174953 | |
| I/B | 5000 | 7222 | 1200 | | | 51367 | |
| | 35 | 6570 | | | | | |
| | | 3700 | 8000 | | | | |
| | | 12640 | | | | | |
| | | 750 | 6250 | | | | |
| B | 13974 | 2762 | 3000 | 140 | 35 | 72445 | |
| | 800 | 4200 | 4374 | 340 | | | |
| | 1419 | 3080 | | | | | |
| | | 2960 | | | | | |
| | | 5272 | 4100 | | | | |
| | | 2260 | 4000 | | | | |
| | | 1190 | | | | | |
| | | 6666 | | | | | |
| | | 450 | | | | | |
| | | 1100 | | | | | |
| | | 1200 | | | | | |
| | | 690 | | | | | |
| | | 1765 | | | | | |
| | | 1035 | | | | | |
| | | 1850 | | | | | |
| | | 3378 | | | | | |
| | | 405 | | | | | |
| B/S | | 3080 | 2950 | | | 25527 | |
| | | 3573 | | | | | |
| | | 8700 | | | | | |
| | | 7224 | | | | | |
| I/B/S | | | 66000 | | | 66000 | |
| S | 834 | 12300 | | | | 13134 | |
| Unknown | 900 | | | | | 900 | |
| Totals | 83355 | 163577 | 244146 | 1158 | 35 | 492271 | |
| | | | | | | 492271 | |
| Average | 5557 | 3804 | 17439 | 386 | 35 | | |

Table A-21: Permits- Purpose by Year

| | WF | WF/MR | MR | Res | Other | Totals |
|---|---|---|---|---|---|---|
| 77 | 5000 | | | | | 5000 |
| 78 | | | | | | 0 |
| 79 | | | | | | 0 |
| 80 | | | 66000 | | | 66000 |
| 81 | | 1190 | | | | 5470 |
| | | 1200 | | | | |
| | | 3080 | | | | |
| 82 | 768 | 456 | | | | 7184 |
| | | 3700 | | | | |
| | | 2260 | | | | |
| 83 | 640 | 2762 | 2950 | | | 36214 |
| | | 4500 | | | | |
| | | 3350 | 4100 | | | |
| | | 1850 | 4000 | | | |
| | | 3080 | | | | |
| | | 5272 | | | | |
| | | 2960 | | | | |
| | | 750 | | | | |
| 84 | 45657 | 4200 | 5282 | | 35 | 88731 |
| | | 3573 | 3264 | | | |
| | | 12300 | | | | |
| | | 7222 | | | | |
| | | 3378 | | | | |
| | | 3820 | | | | |
| 85 | 279 | 2260 | 5976 | 678 | | 25359 |
| | | 6666 | | | | |
| | | 8700 | | | | |
| | | 800 | | | | |
| 86 | 400 | 3085 | | | | 16460 |
| | 6620 | 690 | | | | |
| | | 1765 | | | | |
| | | 3900 | | | | |
| 87 | 834 | 1035 | | | | 1869 |
| 88 | | 12640 | | | | 13600 |
| | | 960 | | | | |
| 89 | | 450 | 8000 | | | 18401 |
| | | 2555 | | | | |
| | | 6296 | | | | |
| | | 1100 | | | | |
| 90 | 644 | 12400 | 6750 | | | 21618 |
| | 1419 | 405 | | | | |
| 91 | 5385 | 4100 | 123000 | 140 | | 138138 |
| | 800 | 1373 | 3000 | 340 | | |
| 92 | 35 | 6570 | | | | 20404 |
| | | 7224 | | | | |
| | | 6575 | | | | |
| 93 | 13974 | | | | | 13974 |
| 94 | 900 | | 6250 | | | 11524 |
| | | | 4374 | | | |
| 95 | | 1125 | 1200 | | | 2325 |
| Totals | 83355 | 163577 | 244146 | 1158 | 35 | 492271 |
| Avg | 5557 | 3804 | 17439 | 386 | 35 | 6564 |
| n | 15 | 43 | 14 | 3 | 1 | 76 |

Table A-22: Permits- Basins and Regions by Purpose

| | Basin 1 Avg | Basin 2 Avg | Basin 4 Avg | Basin 5 Avg | Basin 6 Avg | Basin 7 Avg | Basin 8 Avg | Basin 9 Avg | Delta | Delta Avg | Chenier | Chenier Avg | Coast Avg | Coast |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WF | 7404 | | 25521 | 772 | | 640 | 1775 | 2056 | 68034 | 9719 | 15321 | 1915 | 5557 | 83355 |
| MR | | | 34544 | 5164 | | | 4529 | 33600 | 158832 | 19854 | 85314 | 14219 | 17439 | 244146 |
| WF/MR | 5671 | 3393 | 6468 | 2801 | | 2460 | 2974 | 4256 | 125736 | 3929 | 37841 | 3440 | 3804 | 163577 |
| RE | | | 409 | 340 | | | | | 1158 | 386 | | | 386 | 1158 |
| Other | | | | | | | | 35 | | | 35 | 35 | 35 | 35 |
| Totals | | | | | | | | | 353760 | | 138511 | | | 492271 |

B - FWS's Permit Process Narrative

United States Department of the Interior

FISH AND WILDLIFE SERVICE
825 Kaliste Saloom Road
Brandywine Bldg. II, Suite 102
Lafayette, Louisiana 70508

November 19, 1991

Mr. R. H. Schroeder, Jr.
Chief, Planning Division
U. S. Army, Corps of Engineers
P. O. Box 60267
New Orleans, Louisiana 70160-0267

Dear Mr. Schroeder:

Reference is made to your October 22, 1991, letter requesting a description of the Fish and Wildlife Service's role in marsh management permitting. The requested information is to be used by your office to prepare a programmatic environmental impact statement addressing marsh management. The following input is provided on a technical assistance basis.

Under the authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.), the Fish and Wildlife Service (Service) reviews Section 10/404 permit requests for marsh management activities. The Service provides its findings and recommendations on specific permit requests in reports transmitted to the Corps of Engineers. Service reports on marsh management permit requests typically contain recommendations to modify the design, number, location and/or operation of water control structures. Such modifications are intended to minimize adverse impacts on fish and shellfish nursery use of the affected wetlands, to reduce or eliminate excessive ponding of emergent vegetation, and to increase the success of proposed drawdowns in the restoration of emergent plant coverage in deteriorated wetlands.

Under the authority of the Endangered Species Act of 1973 (as amended), the Service also reviews marsh management permit requests for potential impacts on threatened or endangered species. When adverse impacts are anticipated, the Service advises the Corps of Engineers and provides recommendations to minimize those impacts.

The Service believes that properly planned and operated marsh management projects can be a useful tool in reducing wetland loss and restoring degraded wetlands in coastal Louisiana. We recognize that intensive marsh management may reduce access by estuarine fishes and shellfishes. Through case-by-case review of individual marsh management project proposals, we seek to achieve an optimum balance between long-term wetland conservation and use of managed areas by estuarine organisms.

C - NMFS's Permit Process Narrative

UNITED STATES DEPARTMENT OF COMMERCE
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
Habitat Conservation Division
c/o LSU Center for Wetland Resources
Baton Rouge, Louisiana 70803-7535

November 5, 1991 F/SE024/RH:jk
504/389-0508

Mr. R. H. Schroeder, Jr.
Chief, Planning Division
Department of the Army
New Orleans District, Corps of Engineers
P.O. Box 60267
New Orleans, LA 70160-0267

Dear Mr. Schroeder:

The Baton Rouge office of the National Marine Fisheries Service (NMFS) has received your October 22, 1991, letter requesting a written description of the NMFS review process regarding marsh management permit matters in Louisiana. The following discussion provides the information you requested.

The NMFS is the primary federal resource agency responsible for the management and conservation of marine fishery resources and their habitats. Through review and advisory opportunities afforded by the Fish and Wildlife Coordination Act, the Clean Water Act, the National Environmental Policy Act, and other laws and regulations we consult with federal agencies proposing to construct, permit, or license projects potentially affecting marine fishery resources and their habitats. Some of these resources (e.g., shrimp and red drum) are federally managed through plans developed under the Fishery Conservation and Management Act.

From 1980 through 1990, the NMFS reviewed over 130 public notices advertising marsh management projects. The NMFS recommended permit denial of, or revisions to, approximately 70% of those projects. One reason for our opposition is the impact of water control structures and levees on the production and standing crop of commercially and recreationally valuable marine fishery resources. Researchers have documented significant adverse impacts of marsh management activities to estuarine-dependent fisheries. Herke et al. (1987)[1] reported average decreases of 78% in the production of penaeid shrimp, gulf menhaden, spotted and sand seatrout, and red and black drum, as a result of water management using a water control structure (weir) with a crest elevation of 12 inches below

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1 Herke, W.H., E.E. Knudsen, Z.X. Chen, N.S. Green, P.A. Knudsen, and B.D. Rogers 1987. Final report for the Cameron-Creole watershed fisheries investigation. Baton Rouge: Louisiana State University, School of Forestry, Wildlife and Fisheries, Louisiana Cooperative Fish and Wildlife Research Unit. 419 pp.

marsh level. Many marsh management plans proposed, or in use today, incorporate structure crest elevations, drawdowns, and closure criteria that would result in even greater adverse impacts to fishery production.

In addition, we do not believe that documentation of the positive impacts of marsh management on land loss is adequate. In general, all that can be inferred from recently completed photographic interpretations of 16 sites in coastal Louisiana is that marsh management has mixed but unexplained results on reducing marsh loss rates compared to non-managed control sites. Other important issues which have not been addressed include the impact of failure or abandonment of managed marsh sites and long-term implications of management in the rapidly subsiding coastal zone of Louisiana.

The cumulative impacts of marsh management, both basinwide and statewide, are significant. In the last 10 years, over 200,000 acres of coastal wetlands in Louisiana have been advertised for marsh management via the public notice process. This does not include 500,000 to one million acres impacted by weirs and plugs permitted or constructed prior to 1980, e.g., the 100,000 acre Cameron-Creole watershed area, the wetlands impounded on federal and state refuges, or the Grand and White Lake systems which are affected by control structures and locks. Because of this extremely large area proposed for and under management, and the associated adverse impacts to fisheries production, we believe the development of a comprehensive environmental decision-making document is necessary. The NMFS has routinely recommended permits be withheld until the publication of an Environmental Impact Statement addressing cumulative impacts of marsh management.

With respect to NMFS review of marsh management projects, when we receive a proposal for a marsh management project, we first study the primary management goals to determine if there is a need for the project. Because most marsh management plans now include a project purpose of reducing land loss, we compare a series of aerial photographs of the management area dating from 1968 to 1983, and visit the project site to determine if land loss appears to be a significant problem.

In many cases, projects have been proposed in areas that appear to have changed little in the past 10 to 20 years, where land loss has been caused by single catastrophic events such as hurricanes, or even in healthy, actively accreting marshes. In such areas, the need for proposed management with its corresponding adverse impacts to fishery resources and uncertain wetland benefits often is not justified.

Other than permit denial, primary recommendations made by the NMFS can be grouped in four major categories. The first is to alter structure designs to permit greater fishery access, i.e., putting a vertical slot in a weir, lowering weir crest elevations during

non-critical periods, or opening structures entirely during peak ingress events. The intent is to maximize fishery access while permitting the landowner to manage the property.

A second recommendation is to reduce the duration of fish-excluding events. For example, we believe authorization of frequent or prolonged drawdowns to stimulate vegetation growth is inappropriate. Normally, short and infrequent drawdowns can achieve a desirable level of revegetation. In addition, if structures are to be operated to hold water on the marsh to provide access for hunting or trapping, we recommend the structures be set at low elevations and closed no sooner than one month prior to the hunting/trapping season and opened immediately after the end of the season.

A third recommendation is to alter the salinity closure criteria. Some projects have proposed salinity management objectives that allow structures to be completely closed most of the time. We believe this is unwarranted and that the structure closure provision should be set such that only peak salinities are excluded.

A final recommendation we often make is to implement or improve a monitoring plan. Although marshes have been managed for many years, monitoring of implemented projects has been inadequate. There is a clear need to learn more about adverse and beneficial impacts of marsh management before greater commitments to marsh management are made. In those areas where monitoring has shown management to be unproductive or having adverse impacts, we believe management practices should be discontinued or the plans revised based on sound scientific data.

If you require additional information, contact me or staff of this office at your convenience.

Sincerely yours,

Rickey N Ruebsamen

Rickey N. Ruebsamen
Branch Chief

# D - NRCS's Project Process Narrative

None Received- Can Be Included in Final PHMEIS

E - DNR's Permit Processing Narrative

None Received- Can Be Included in Final PHMEIS

F - EPA's Permit Process Narrative

The United States Environmental Protection Agency has initiated a process that will result in the formulation of a policy on the management of marshes. In lieu of promulgation of that policy, the Agency has submitted the following:

Under Section 404 of the Clean Water Act, the U.S. Army Corps of Engineers (COE) and the U.S. Environmental Protection Agency (EPA) jointly administer the 404 permit program.

Under Section 404, the COE is authorized to issue permits for the discharge of dredged or fill material into waters of the United States, subject to an EPA "veto" if the discharge has certain unacceptable impacts. EPA has the authority to review each permit application and to submit comments pursuant to the 404(b)(1) guidelines. The 404(b)(1) guidelines were developed by EPA in conjunction with the COE to evaluate proposed discharges of dredged or fill material. Utilizing the guidelines, an EPA permit review focuses on evaluating practicable alternatives, minimizing impacts, and mitigating for unavoidable impacts to the aquatic ecosystem, including wetlands.

Section 404(c) of the Clean Water Act gives EPA the authority to "veto" a permit if the discharge will have unacceptable adverse impacts on the aquatic or wetland ecosystem.

G - NOD's Permit Processing Narrative

The Corps of Engineers issues permits for marsh management under the authorities of Section 10 of the River and Harbor Act and Section 404 of the Clean Water Act. Section 10 authorization is needed for dredging and other work, such as the installation of structures, in or affecting navigable waters, including tidal wetlands. Section 404 authorization pertains to the deposition of dredged or fill material in waters of the United States, which includes navigable waters and adjacent wetlands. As part of our evaluation leading to a permit decision, we conduct a public interest review to ensure that the activity is not contrary to the overall public interest. This review relies heavily upon comments which we solicit from the general public and from various resource agencies by issuing a public notice describing the project. All comments which we receive are compiled and addressed in an environmental assessment which also describes the purpose and need for the project, discusses alternatives which would eliminate or reduce project impacts and assesses the beneficial and adverse project impacts. In addition to preparing the environmental assessment, which is required by the National Environmental Policy Act (NEPA), we also perform a 404(b)(1) evaluation to ensure that the project complies with guidelines set forth under the Clean Water Act. The amount of time required to complete processing varies greatly and may range anywhere from a few months to over a year. Delays are most often caused by having to request additional information from the applicant and by attempting to resolve objections to the project. It is also important to note that most marsh management plans require permits from the Louisiana Department of Natural Resources Coastal Management Division (CMD) and the Department of Environmental Quality Office of Water Resources (DEQ). We cannot issue our permit until after these state authorizations have been granted.

The majority of marsh management plans which we process are located within the Louisiana Coastal Zone (CZ); therefore, they are processed jointly by us and CMD. For those projects in CZ, the applicant submits his application to CMD who then forwards a copy to us for processing. If the project is outside the CZ boundaries, the applicant submits his application directly to us. The incoming application is assigned to a project manager who is responsible for all aspects of processing as well as post-issuance inspections and review of monitoring data. In order for us to begin processing, the application package must contain a clear vicinity map, a drawing showing the management area, various subunits or conservation treatment units, if applicable, and structure locations, a plan view and cross-section of proposed work, quantities of dredged and/or fill material, structure diagrams and an operational scheme for the structures. The application must also contain a statement describing the purpose of the project and a list of adjacent

landowners. We will contact the applicant or agent and request any information which has not been provided. Once we have all of this information, we issue a public notice describing the project. For projects inside the CZ, the public notice is usually issued jointly with CMD, which means that only one public notice is used to solicit comments for our permit program and CMD's. The public notice is distributed to all adjacent landowners, numerous state and federal agencies, and individuals and organizations on our public notice mailing list. We forward comments we receive during the comment period (usually 20 days) to the applicant for his consideration. The applicant is not required to address objections; however, he must inform us of whether or not he intends to rebut or attempt to resolve them.

During the comment period we typically receive comments from the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service. For projects in the CZ, state agencies submit their comments directly to CMD with copies to us. We are required to give full consideration to comments which we receive from the various federal agencies. Because these agencies have different mandates, their comments and recommendations often conflict with one another, and we are faced with the difficult task of evaluating the validity of these comments and deciding which of the recommendations, if any, to require the applicant to adopt. The decision is made even more difficult due to the widely differing opinions as to the effectiveness and impacts of marsh management. Although we have had several instances when one or more of the agencies recommended denial of a marsh management plan, recommendations most often received during the public notice comment period usually involve changes in the design or operation of proposed water control structures. We attempt to satisfy the concerns of all of the agencies; however, in most cases this is impossible because of their differing views. Typically, we recommend a plan which is a compromise between all parties involved; however, we will not recommend changes if we do not find them to be necessary, if they are not practicable or if they would defeat the purpose of the project. If we determine that a project would result in unacceptable adverse impacts and that the project cannot be modified without defeating the objectives, we will deny the permit. In all cases, we have the responsibility for making the final permit decision. Agency input is only utilized to the extent that it assists us in making our decision.

Agency comments usually assist us in evaluating environmental impacts which may be caused by a particular marsh management project. However, we must also address many other factors which are beyond the purview of any one agency. We must consider the applicant's purpose and need for the project and weigh the anticipated benefits against

any adverse impacts which are likely to occur. We take into account a host of environmental and socioeconomic concerns such as impacts to hydrologic patterns, substrate conditions, flood control functions, navigation, water quality, air quality, wetlands and wetland-dependent resources, threatened and endangered species, cultural resources, aesthetics, economics, safety and energy needs. We are also required to address secondary and cumulative impacts which the project may cause or contribute to. In the event we determine that impacts would be significant, NEPA requires that we prepare an Environmental Impact Statement (EIS), which necessitates a much more rigorous evaluation of the project. Despite the tendency by many to argue for or against a particular project based upon generalizations about marsh management, we never lose sight of the fact that each project and each project site is different. Although previous studies or prior experience in other areas may give us some clues as to what may or may not happen if a plan we are considering is implemented, we evaluate each plan on its own merit using the best and most relevant information available to us at that time.

In order for us to evaluate the project and to address recommendations submitted by the agencies, we generally have to request that the applicant provide additional information. Much of this information is necessary in order to document the need for the project and to determine how the project will affect the physical environment and biological resources in the proposed management area as well as in surrounding areas. Information typically requested includes data on hydrologic patterns and water levels, historical salinity data, land loss trends in the area and biological resources on the property. We may also request that the applicant consider various alternatives which we believe may accomplish project objectives while minimizing potential adverse effects. During or prior to our evaluation, we normally arrange a trip to the site in order to gain a better appreciation of what the applicant is attempting to accomplish and what resources may be affected.

The evaluation phase of the permit process often causes the most lengthy delays; therefore, it is highly recommended that an applicant arrange an interagency meeting and/or field trip even before he submits his application. A pre-application meeting educates the agencies on what the applicant wants to accomplish and also lets the applicant know what the various agency positions will be. The applicant may elect to incorporate agency recommendations at this time so that at least some of their concerns are addressed prior to making application and going on public notice. Changes made late in the process may cause delays because of the need to prepare new drawings, coordinate the changes with the various agencies and in cases where the changes are substantial, to issue a new public notice.

If we are satisfied that the project is needed, that it is the least environmentally damaging practicable means to accomplish project objectives and complies with other provisions of the 404(b)(1) guidelines and that the work is not contrary to the overall public interest (i.e., anticipated benefits outweigh the potential negative impacts), we will issue a permit. As mentioned previously, permits for projects requiring a Coastal Use Permit from CMD or Water Quality Certification from DEQ cannot be issued until these authorizations have been granted. Our marsh management permits are conditioned to require that the applicant adhere to the water control structure operational schedule agreed upon during the permit process. In addition, they typically contain requirements for monitoring specific physical and/or biological parameters in order to determine if the project is effective in accomplishing its objectives and to ensure that it is not causing unacceptable adverse impacts. We believe monitoring to be necessary given the uncertainties involved in predicting marsh management impacts. It also provides the applicant with information needed to make wise management decisions in the event the management plan is not working effectively.

Once we make a preliminary decision to issue a permit, we are required to notify any of the federal agencies which have unresolved objections to the project. Under certain circumstances, an agency disagreeing with our decision may request that the decision be "elevated" to a higher level. This referral procedure and the circumstances allowing such a referral are spelled out in Memoranda of Agreement with the various federal agencies. This process could delay final action by several months; however, we have rarely had a marsh management permit decision referred for higher level review.

# H - Basin-by-basin Landscape Characterizations

## Summary

When considering the location of a marsh management plan to stop, slow, or reverse conversion of land to water, an understanding of how natural physical processes, and man's actions, have interacted to create the current marsh landscape provides insight into future landscape configurations. Specifically, historic land loss trends and probable causes may help identify realistic goals for a project; or determine whether the proposed project is appropriate.

## Procedures

### Overview

What follows is a general framework within which marsh management/hydrologic restoration plans can be considered relative to past, present and future landscapes in eight of the nine hydrologic units defined by Chabreck, 1972 (Fig. 1). This was accomplished by addressing the following questions: 1) Where, and how much, land loss has occurred since the 1930's?; 2) What is the current land loss trend for each hydrologic unit?; 3) What are the primary probable causes for the observed trends?; and, 4) What is the land loss trend likely to be over the next 20 years?

### Introduction

Over the past 7,000 years five major delta complexes have prograded into coastal Louisiana (Figure 2). Progradation of these deltas is responsible for the formation of two distinct geomorphic regions; the deltaic plain in the central and southeastern portions of coastal Louisiana and the chenier plain in the southwestern part of the state. In the deltaic plain, shifting courses of the Mississippi River led to the deposition of sediments over an area of approximately 15,000 square miles (Fisk, 1944; Kolb and Van Lopik, 1958; Frazier, 1967). The end result of this long period of deltaic sedimentation has been the formation of a vast expanse of marsh and swamp separated by abandoned courses and distributaries. In contrast, the chenier plain formed by longshore transport of fine-grained Mississippi River sediments that were deposited to the west of the deltaic plain. These sediments, transported by westward flowing nearshore currents, were eventually deposited along the existing shoreline as mudflats. When deposition ceased or declined due to shifting Mississippi River courses, these deposits were reworked by coastal processes, concentrating the coarse grained sediments, and forming shore-parallel ridges called "cheniers" (Gould and McFarlan, 1959; Byrne et al, 1959). Introduction of new sediment by westward shifts of the Mississippi River delta resulted in the

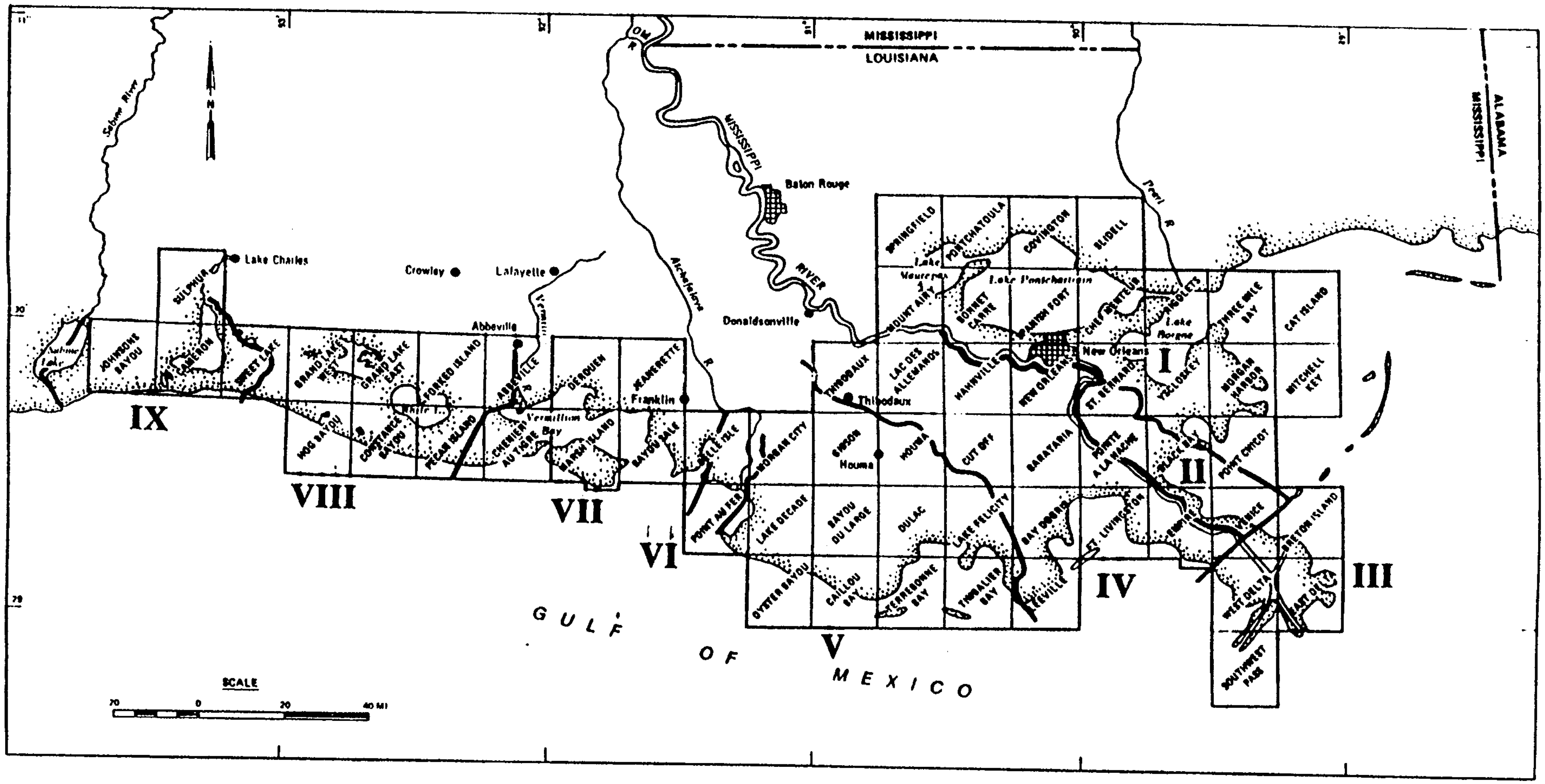



Figure 1. Hydrologic units of the Louisiana coastal marshes.

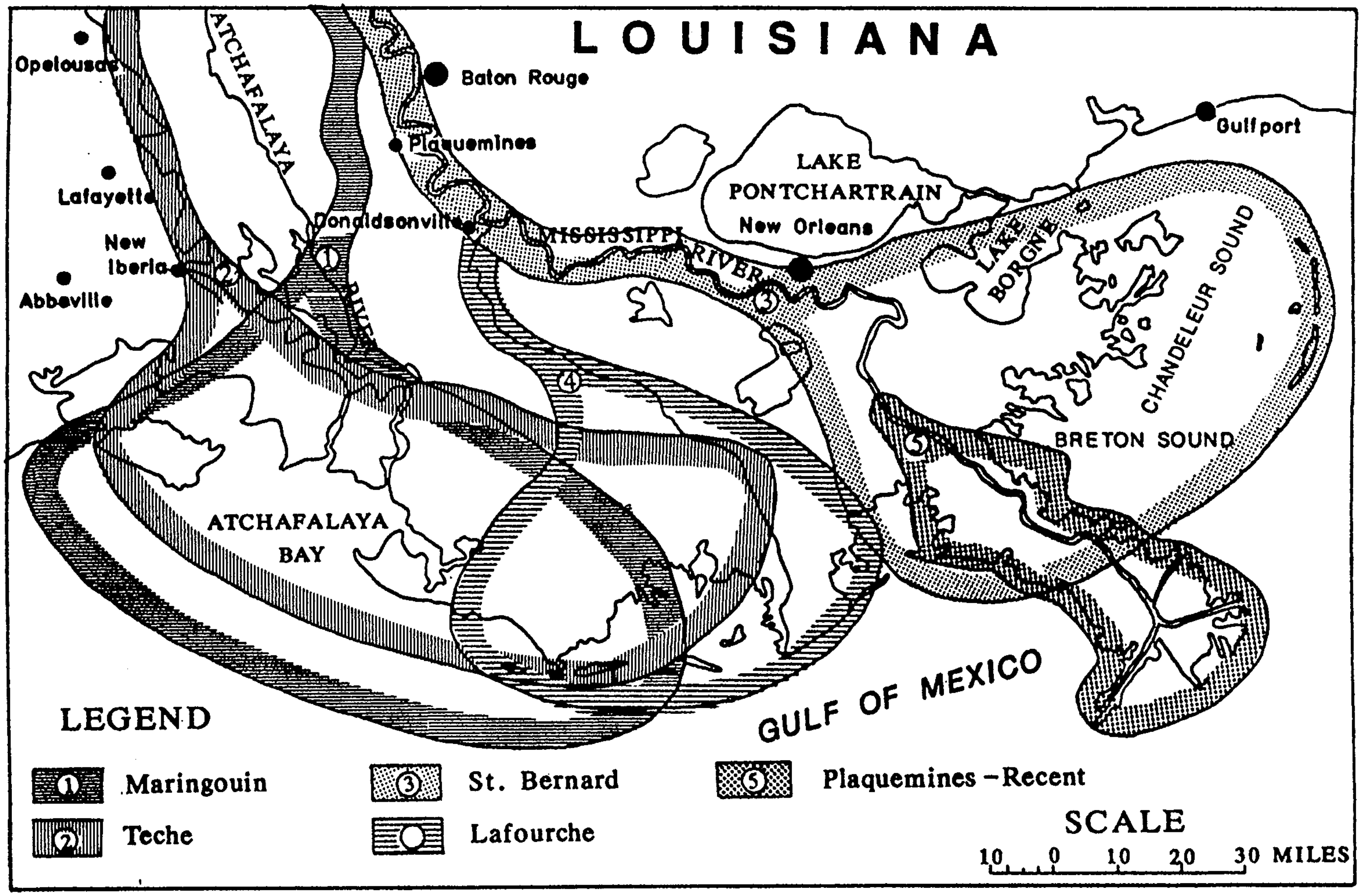



Figure 2. Delta complexes comprising the Mississippi River deltaic plain (from Kolb and Van Lopik 1966)

isolation of these ridges by accretion of new material on the existing shoreline. Numerous cycles of deposition and erosion have been responsible for creating the alternating ridges separated by marshlands which are characteristic of the chenier plain.

Until the early 1900's, land building processes dominated in the Mississippi River deltaic and chenier plains. Since then, this trend of land building has reversed and the Louisiana coastal zone is losing land at a high rate, particularly in the deltaic plain (Turner and Cahoon, 1987; Dunbar et al., 1992). Land loss during the past 60 years is responsible for the destruction of hundreds of square miles of wetlands. Causes for this loss range from man's activities (i.e. canal dredging, channelization of streams, levee construction, and hydrocarbon extraction) to various natural phenomena such as subsidence, wave and current erosion, and subsurface geologic control (Penland et al., 1990).

Land Loss Data Sets

There are two sources of land loss data that encompass the Louisiana coastal zone that can be used for this effort. For the purpose of the PMMEIS the NOD's Geologic Environments and Land Loss (GELL) Geographic Information System (GIS) was used to determine historic land loss trends and predict future loss trends. The basis for that decision is discussed below.

One available data base is the U.S. Fish and Wildlife Service/Louisiana Department of Natural Resources (FWS/DNR) GIS. The other is the GELL GIS system compiled and maintained by the New Orleans District (NOD), Corps of Engineers. A major problem with both GIS data bases is that neither was specifically designed to predict future marsh landscapes. Additionally, they were conceived for different reasons, and track and measure different attributes of the landscape using different techniques at different points in time. Thus, regardless of which GIS was selected, care must be taken in using them to do something they were not specifically designed to do. The choice of one over the other must hinge on other factors. The NOD's data base focuses on measuring reductions of land acreage over time but is also complimented with data on engineering geology, subsidence, and depth to the Pleistocene surface. Land loss acreages have been determined for four time intervals over a continuous period spanning about 60 years (1930's to 1990). The 1930's to 1956/58 time interval in the NOD's data base serves as an historic benchmark against which the relative higher land loss rates observed in the 1960's and 1970's can be evaluated. The FWS/DNR data base focuses on delineating habitat types. This data base currently consists of three temporal data points (1955, 1978, and 1988). Despite the differences, both data bases provide similar estimates of land loss rates and trends for the time period which is common to both. Because NOD's database contains additional

land loss data, as well as data on engineering geology and subsidence which supplement the land loss data for determining causes and future trends of land loss, we chose this database for use in this study.

Calculation of Land Loss

Land loss during each of the four time periods was determined by comparing the 1930's base map with subsequent aerial photographic coverages, and delineating those areas which were land in the 1930's and had become water. Water was classified as any area of water having no permanent vegetation visible at the surface. Permanent vegetation, for purposes of this study, is that which is attached to the substrate, not floating vegetation such as hydrilla and hyacinths. Land was simply defined as everything on the photograph not classified as water. Areas of accretion were not mapped in the Corps study. However, a previous study by the Corps of Engineers (May and Britsch, 1987) showed that except for the modern Mississippi River Delta and the Atchafalaya Delta, land gain throughout most of coastal Louisiana is negligible. Therefore, areas of open water or loss on earlier photographs that subsequently became vegetated were not identified. The land loss data is presented in two ways. One is average square miles of loss per year and the other is average percent of land lost per year. When presented as square miles per year the rate of loss is somewhat independent of the area mapped. Even though the rate is accurate it doesn't fully reflect the physical setting in which the rate of loss is taking place. For example, the average rate of loss may be 1.0 sq mi/yr for a quadrangle located at the coast with a low percentage of land area. The rate of 1.0 sq mi/yr is probably more significant for the quadrangle located on the coast because in terms of the loss rate it represents a much larger percentage of the original land area. When the loss rate is presented in square miles only, this point tends to be lost. Therefore, the land loss rates are also presented as percent lost per year. By converting the loss rate to percent, the data is normalized for the entire coastal area so that regardless of where the area is, it can be compared with another area on an equal basis with regards to loss. This is an important consideration when comparing and contrasting areas relative to land loss rates. The land loss trends determined for each hydrologic unit, combined with historic land use/geologic data provide valuable insight into the causes of land loss within each unit.

Causes of Land Loss:An Overview

There are numerous causes of land loss in coastal Louisiana. Loss is commonly the result of several causes acting together. Relative subsidence has been a major contributor to land loss in coastal Louisiana for thousands of years. Long-term relative subsidence rates in coastal Louisiana range from 0.25 to 5.0 feet

per century. Relative subsidence will continue to be a contributor to the observed land loss in the future. However, since approximately 1960, the land loss rate has increased dramatically, inconsistant with the long term (100's of years) trend of loss. It is the causes of this more recent loss which are the main focus of this write-up. All of the observed losses are occurring on a landscape which is undergoing relative subsidence. To a large extent, the alterations which have been superimposed on this subsiding landscape have led to the recent higher rates of loss. Throughout coastal Louisiana the following three general causes of loss appear to be responsible for a large percentage of the recently observed land loss:

1. Shoreline erosion. Shoreline erosion is loss due to the physical removal of material by wave and current action. Waves are generated by wind action as well as from boat traffic. Shoreline erosion along the coast and lakes is especially severe during the passage of cold fronts and tropical storms. Shoreline erosion is usually greatest on points and along barrier islands where wave energies are focused. Erosion along channels and canals (both natural and man-made) is mainly due to waves and drawdown generated by boat traffic.

2. Altered hydrology. Alterations to the natural surface hydrology result from activities such as the construction of roads, levees, canals, and navigation channels and their relationship with natural geomorphic features. These features commonly restrict surface drainage and tidal exchange by creating areas which are impounded or semi-impounded.

Altered hydrology resulting from impoundments or semi-impoundments has been linked to marsh loss (Turner and Cahoon, 1987; and Scaife, Turner, and Constanza, 1983). Most of the loss caused by alterations to the hydrology is located in the interior wetlands and is referred to as interior land loss. These alterations to the hydrology can result in prolonged periods of elevated water levels relative to areas outside those affected, and in some instances, unnaturally low water levels. The impoundments or semi-impoundments retard movement of water out of the wetlands; especially after heavy rains or flood events leading to a relative rise in water levels. They also restrict flow into the wetlands, blocking nutrients and water during drier periods.

If the water surface elevation is lowered (naturally or artificially) for an extended period of time, the upper organic zone may be dewatered and possibly oxidized resulting in a loss of surface elevation or subsidence. The result will be a relative rise in water level that could negatively impact existing vegetation. The effects of salt water intrusion may increase because storm surges or abnormally high tides that get into the wetlands are retained longer due to the restricted drainage. The overall increase in relative water levels within many of these impounded or semi-impounded areas also increases

the the physical removal of material by wave and current action. Because water levels are elevated, more surface area is exposed to erosion.

Another consequence of altered hydrology may be an increase in tidal exchange and drainage resulting from canals and waterways that are dredged into previously isolated wetlands. This may lead to tidal scour and salt water intrusion which contributes to land loss.

Land loss resulting from altered hydrology is usually due to a combination of the impacts listed above.

3. Direct man-made loss. This is loss from dredging related activities such as navigational waterways, oil and gas exploration, borrow pits and canals, aquaculture and disposal ponds, and drainage canals.

## Unit 1

### Location

Hydrologic Unit 1 encompasses the Lake Maurepas, Lake Pontchartrain, and Lake Borgne drainage systems. The Unit is bounded by the Pleistocene Terraces on the North and West and extends eastward to the Chandeleur Islands. The southern boundary begins at Breton Island and runs northwest to Mozambique Point, then northwest up Bayou Terre Aux Boeufs to the town of Delacroix, then north up Louisiana Highway 300 to Reggio and west along Hwy 46 to Poydras and the Mississippi River. The boundary then follows the Mississippi River to Donaldsonville (Fig. 1).

### Geologic Setting

Unit 1 is located in the extreme northeastern portion of the Mississippi River deltaic plain. This Unit is generally comprised of inland swamp and brackish marsh in the western portion, brackish marsh in the central portion and brackish and saline marsh in the eastern portion. Dominant physiographic features include the Mississippi River and its associated natural levee, Lakes Maurepas, Pontchartrain, and Borgne, the Mississippi River Gulf Outlet, and the numerous abandoned distributaries related to past delta development. Elevations in the unit range from +15 feet NGVD on the natural levees bordering the Mississippi River to near 0 feet NGVD in the coastal marshes.

Typical geologic profiles in the area show characteristic depositional environments of the deltaic plain. The Holocene sediments are relatively thin (<25 feet) in the extreme western portion of Unit 1 and thicken gradually to approximately 180 feet in Chandeleur Sound. The surface and shallow subsurface environments are composed of swamp and marsh deposits separated

by abandoned distributaries. Marsh deposits are composed of organic clays and peats. Swamp deposits are generally soft to medium clay with minor amounts of silt and organics. Natural levee deposits are oxidized, medium to firm clays and silt, having lower water content and higher compressive strengths than the surrounding environments making them less susceptible to erosion. Beneath the marsh, swamp, and natural levee deposits are interdistributary deposits ranging from 10 feet thick in the western portion of the Unit to 40 feet thick in the eastern portion. Interdistributary deposits are composed of very soft clays with minor amounts of silt. Prodelta deposits underlie interdistributary deposits and range from 5 feet thick in the western portion of Unit 1 to 100 feet thick in Chandeleur Sound. They are composed of medium clays with minor amounts of silt. Below the prodelta deposits are nearshore gulf deposits. They are approximately 5 feet thick, and are composed of silts, sands, and shell. Nearshore gulf deposits lie unconformably on the Pleistocene surface.

The Pleistocene surface outcrops west of Lake Maurepas and north of Lake Pontchartrain. It is located at approximately -25 feet NGVD below Lake Maurepas, -50 feet NGVD below Lake Pontchartrain, -50 feet NGVD near Chef Menteur, -80 feet NGVD near Shell Beach, -135 feet NGVD near Point Chicot, and -180 feet NGVD in Chandeleur Sound. Pleistocene deposits are generally very stiff, oxidized clays with low water content and high compressive strengths. The Pleistocene represents the most stable surface in coastal Louisiana with regards to subsidence. Generally, where the depth to the Pleistocene is shallow (<50 feet), subsidence rates are relatively low. The relatively shallow depth to the Pleistocene surface in the western half of Unit 1 is largely responsible for the relatively low subsidence rates in this area. Long-term, relative subsidence rates for the western portion of Unit 1 average approximately 0.4 feet/century. The depth to the Pleistocene surface gradually increases eastward until it reaches approximately -180 feet NGVD in Chandeleur Sound. Average subsidence rates in the eastern half of Unit 1 are over 0.5 feet/century. Because most of the sediments in Unit 1 were deposited by the St. Bernard Delta which became active approximately 4000 years before present, the rapid subsidence associated with more recent deltaic deposits has already taken place. Therefore, Unit 1 does not exhibit the higher subsidence rates common in more recent deltas in the deltaic plain.

Historic Land Loss

The average yearly land loss rate for Unit 1 was 1.59 square miles for the 1932 to 1958 period. The rate almost doubled to 3.52 sq mi/yr during the 1958 to 1974 period. The rate decreased to 2.58 sq mi/yr for the 1974 to 1983 period and continued to decrease to 1.92 sq mi/yr for the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend. The percentage loss rate peaked at 0.26 percent per

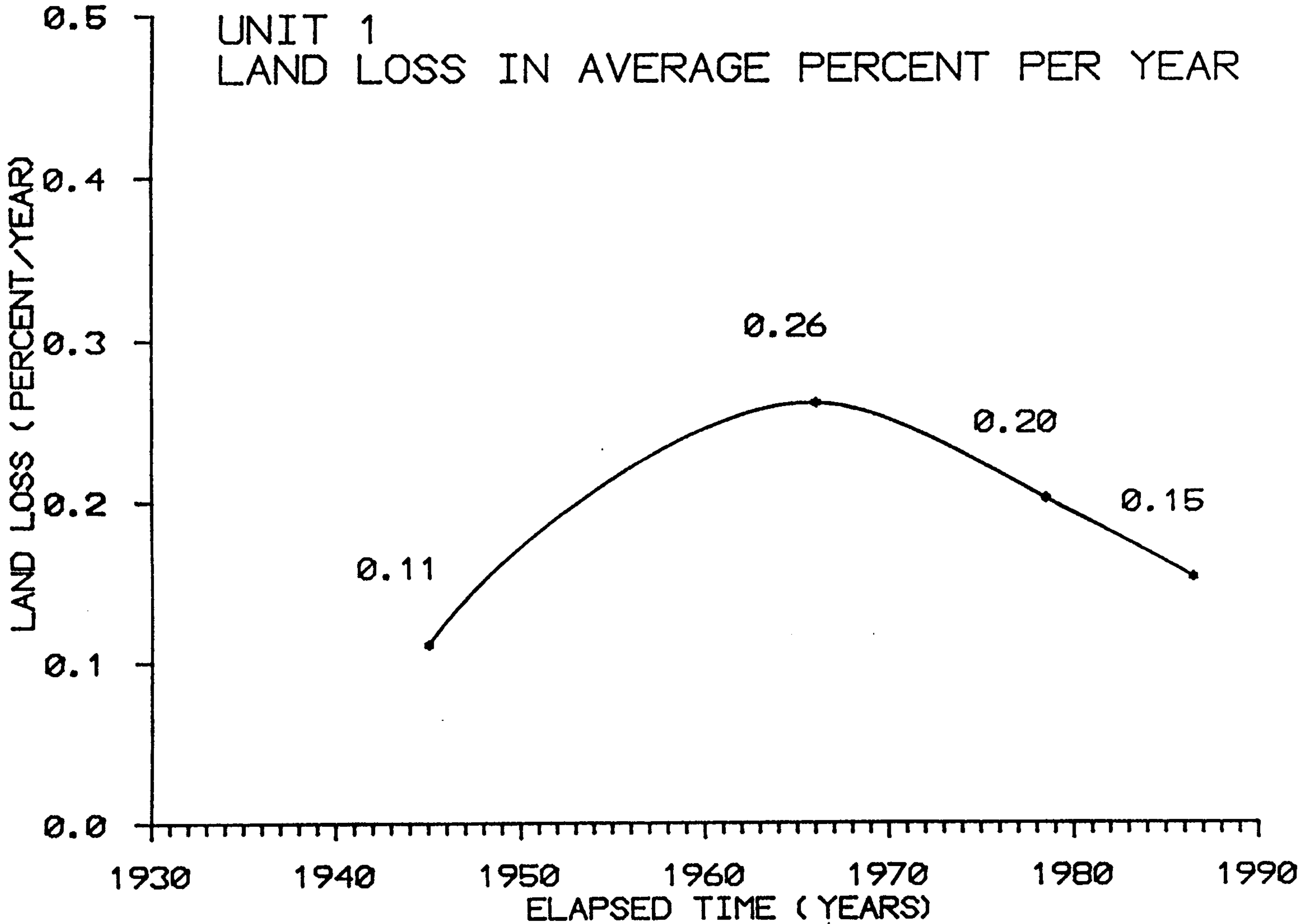

UNIT 1
LAND LOSS IN AVERAGE PERCENT PER YEAR
0.5
0.4
0.3
0.2
0.1
0.0
LAND LOSS ( PERCENT/YEAR)
0.11
0.26
0.20
0.15
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)

Figure 3.

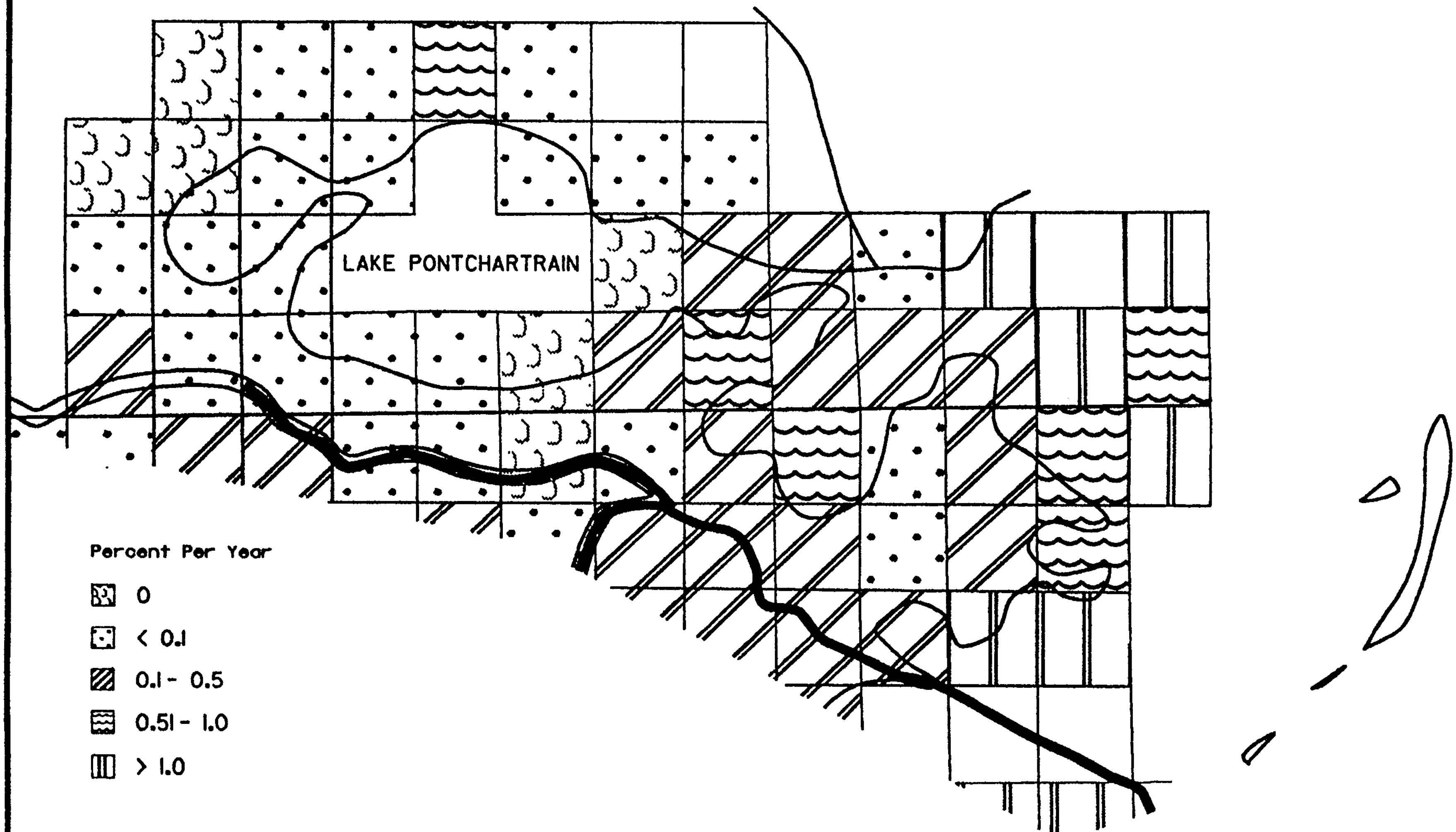



Figure 4. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

year during the 1958 to 1974 period. It began to decrease after 1974, and was 0.15 percent per year during the 1983 to 1990 period (Figure 3). By 1990, Unit 1 had lost approximately 10 percent of the land area present in 1932. As shown in Figure 3, the highest loss rate occurred during the 1958 to 1974 period which is common for most of coastal Louisiana. Direct man-made loss accounted for approximately 17 percent of the total loss from 1932 to 1990. Over half of the direct man-made loss occurred during the 1958 to 1974 period. Figure 4 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey (USGS) quadrangles approximating Unit 1. This figure shows that the western portion of Unit 1 is generally losing less than 0.1 percent of its land area each year. The central portion is losing between 0.1 and 0.5 percent per year, and the eastern portion is losing 0.1 to over 1.0 percent per year.

Location of Historic Loss

Following are lists of areas which have experienced relatively high loss rates. These lists do not include all possible sites, but they do identify many areas which have experienced high land loss throughout Unit 1.

Some areas which have experienced relatively high rates of interior marsh loss in Unit 1 include:

1. north and south of Interstate 10 near Labranche
2. approximately 3 miles west of Madisonville, north of the Lake Pontchartrain shoreline
3. south of Lacombe between the Pleistocene Terrace and the Lake Pontchartrain shoreline
4. within the Bayou Savage Refuge
5. north and south of Bayou Bienvenue between the Intracoastal Waterway and the Mississippi River
6. the Fritchie marsh, north of the Rigolets
7. east of Bayou Terre aux Boeufs between Reggio and Delacroix
8. between Hwy 11 and Bayou Bonfouca
9. just west of Paris road south of Bayou Bienvenue

Some areas where shoreline erosion rates have been especially high include:

1. the south shoreline of Lake Maurepas
2. the shoreline north and south of Pass Manchac in Lake Pontchartrain
3. the southwest shoreline of Lake Pontchartrain
4. the shoreline of Lake Pontchartrain just west of Chef Menteur Pass
5. Goose Point on the north shore of Lake Pontchartrain
6. Alligator, Shell, and Proctor Points and Point aux Marchettes in Lake Borgne
7. the southeast and southwest shoreline of Lake Borgne

8. the north bank of the Mississippi River Gulf Outlet
9. La Petit Pass Island, Grand Island, and Isle Au Pitre in Mississippi Sound
10. Door Point, Brush, Martin, and Comfort Islands, and Mitchell Key in Chandeleur Sound
11. Deadman, Grace, Mozambique, and Gardner Points and Point Chicot in Breton Sound

Some sites where direct man-made loss has been relatively high include:

1. the Mississippi River Gulf Outlet
2. the Gulf Intracoastal Waterway
3. the borrow areas for Interstate 55
4. the Inner Harbor Navigation Channel

The approximate date, location, and morphology of the land loss provides insight into the major causes of loss. From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) for the Pontchartrain Basin, the primary causes of historic land loss in Unit I appear to be shoreline erosion, alterations to the natural surface hydrology, and direct man-made loss from dredging.

## Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased significantly since the 1958 to 1974 period. The main reason for this decrease was the reduction in interior marsh loss since 1974. Since 1974 a larger percentage of land loss in Unit 1 has been due to shoreline erosion.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. the shorelines of Lake Pontchartrain, Lake Borgne, Mississippi Sound, Chandeleur Sound, and Breton Sound; especially where the shoreline protrudes into these open water areas. The shorelines of Breton and Chandeleur Sounds are most vulnerable because they receive the highest energy waves and currents
2. the interior marshes north and south of Bayou Savage and in the Fritchie marsh where altered hydrology continues to cause marsh loss
3. the north bank of the Mississippi River Gulf Outlet; especially where the bank intersects small ponds and bays
4. south of Lacombe between the Pleistocene terrace and the Lake Pontchartrain shoreline
5. the shoreline of Lake Pontchartrain just west of Chef Menteur Pass

6. between Hwy 11 and Bayou Bonfouca

In the areas identified in 2, 4, and 6, alterations to the hydrology will likely be responsible for future losses.

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. Areas where the eroding lake shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from the large lakes to act directly on previously protected interior marshes. This has or will likely occur at the following locations:

a. near Pt aux Herbes in Lake Ponchartrain

b. in the vicinity of Goose Point on the north shore of Lake Ponchartrain

c. about 4 miles south of Pass Manchac

d. on Proctor Point in Lake Borgne

e. the shoreline bordering the numerous lakes and small bays in the marshes adjacent to Mississippi, Chandeleur, and Breton Sounds where the shoreline has eroded or will erode into these areas

The direct man-made loss due to dredging activity in Unit 1 has decreased since 1974 and will probably continue to decrease.

Permits

Six marsh management permits have been issued within Unit 1 (see Figure ?). Waterfowl management/marsh restoration are the primary purposes stated for these projects. The major structural elements of these projects are water control structures.

Only #156-A and a portion of #65 have experienced high rates of land loss in the past 60 years. All the permitted projects generally focus on water level control and prevention/reduction of salt water intrusion as actions intended to benefit marsh growth and help prevent future loss of these areas. However, only at #156-A, and some of the lake shoreline on #65 does significant land loss seem imminent. A review of land loss, subsidence, and geologic/geomorphic data from several time periods suggest that high relative water levels in the area south of the railroad on #156-A have contributed to past land loss. Thus, projects designed to affect relative water levels in this area may prove effective at reducing loss rates. Shoreline erosion on the Lake Borgne side of #65 may cause the shoreline to intersect isolated ponds of the interior marshes exposing them to lake processes and increased erosion. Five of the six previously permitted projects are wholly or partially contained on the CWPPRA list of proposed projects.

CWPPRA

The restoration plan developed under the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) for the Pontchartrain Basin summarized the existing conditions, identified the problem areas for the Basin, and proposed projects to address these problem areas. The Pontchartrain Basin closely approximates Hydrologic Unit 1 as defined by Chabreck, 1972. As summarized from CWPPRA, the primary causes of wetland loss in the Pontchartrain Basin are the interrelated effects of relative subsidence, erosion, saltwater intrusion, and human activities. The most significant human activity was the construction of the Mississippi River levees which eliminated fluvial processes that nourished wetlands with fresh water and sediment. Other significant human activities include the filling, draining, flooding, or dredging of wetlands, and the saltwater intrusion, direct construction impacts, and erosion associated with the MRGO.

The 4 critical problems identified in the restoration plan are: 1) increased salinity and reduced sediment and nutrient input, 2) MRGO bank erosion, 3) possible loss of land bridges, and 4) possible loss of critical areas where marsh loss is imminent. Figure ? shows the location of the proposed marsh management projects in Unit 1 from the CWPPRA Plan. Five of these projects have been partially or wholly permitted and are discussed somewhat under "Permits".

The area covered by proposed projects PO-6, PO-9A, XPO-52A, and XPO-52B have experienced considerable interior marsh loss in the past 60 years. However, in the previously permitted portion of PO-9A, minimal historic loss has occurred. PO-6 and PO-9A both involve introduction of fresh water and some sediments which will benefit these areas assuming that the water can be directed through the marshes. However, at PO-6, historic land loss data suggests that relative water level rise may have contributed to marsh loss. Therefore, any project designed to increase water flow into this area should address how excess water will be removed.

Marsh loss at XPO-52A&B appears to be the result of relative water level rise. Thus, removal of excess water should reduce future loss in these areas.

Land loss in the areas covered by projects XPO-51, PPO-19, and PO-15 has been relatively minimal over the past 60 years except for relatively high rates of shoreline erosion along the lake shorelines and an area of interior marsh loss in PPO-19. Shoreline erosion rates are expected to remain approximately the same over the next 20 years except where the shoreline breaks through to interior ponds exposing easily erodable material to lake processes. Measures to reduce shoreline erosion in these areas may prevent the lake shore from intersecting interior ponds, thereby reducing loss rates.

The project area of XPO-84 has experienced relatively little land loss since 1932. What loss has occurred is mainly shoreline erosion around existing ponds. This shoreline erosion is expected to continue.

The area covered by XPO-71 is part of the MRGO disposal area and is dependent on levees and culverts to maintain water levels. If this area is to continue as a marsh, water control devices will have to be maintained.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that specifically address the areas of past and anticipated future loss listed above under "Location of Historic Loss" and "Future Areas of Loss".

The CWPPRA Plan estimates that nearly 24,960 acres (9%) of the Basin's existing marshes will be converted to open water in the next 20 years without implementation of proposed projects, with losses concentrated in the middle and lower basin and on the land bridges. Approximately 32,800 acres of swamp are projected to be lost in 20 years on the Pontchartrain/Maurepas land bridge and in the middle basin. The majority of the swamp acreage will convert to marsh. The CWPPRA land loss projections were made by applying the land loss rate determined for the 1974 to 1990 period to the 1990 land area and extrapolating it to 2010. This method of projection may be appropriate when estimating loss over the entire Basin, but should be avoided for site specific areas which are dynamic with respect to land loss.

Summary

In summary, both the square miles and percentage of land being lost annually in Unit I has decreased significantly since the 1958 to 1974 period. The main reason for this decrease was the reduction in the amount of interior marsh loss since 1974. Since 1974, an increasing percentage of land loss appears to be related to shoreline erosion. As shown in Figure 4, during the 1983 to 1990 period the western portion of Unit I generally lost less than 0.1 percent of its land area each year. The central portion generally lost between 0.1 and 0.5 percent per year, and the eastern portion lost from 0.1 to greater than 1.0 percent per year. The high percentage loss rates in the eastern portion of Unit I is mainly the result of high rates of shoreline erosion due to high energy waves and currents in the vicinity of Breton, Chandeleur, and Mississippi Sounds.

The overall rate of loss in Unit I should remain relatively constant over the next 20 years assumming interior marsh loss and direct man-made loss remain low. Shoreline erosion will likely continue to be a dominant cause of loss in this Unit. Each proposed project should be analyzed to document/verify active and/or projected causes of loss. This will help to insure that the proposed solution matches the perceived problem, resulting in a viable project.

## Unit 2

### Location

The northern bounbary of Unit 2 follows the southern boundary of Unit 1 from Breton Island to the Mississippi River. It then follows the Mississippi River downstream to a point approximately 2 miles south of Boothville. The boundary then turns northeast to Breton Island (Fig. 1).

### Geologic Setting

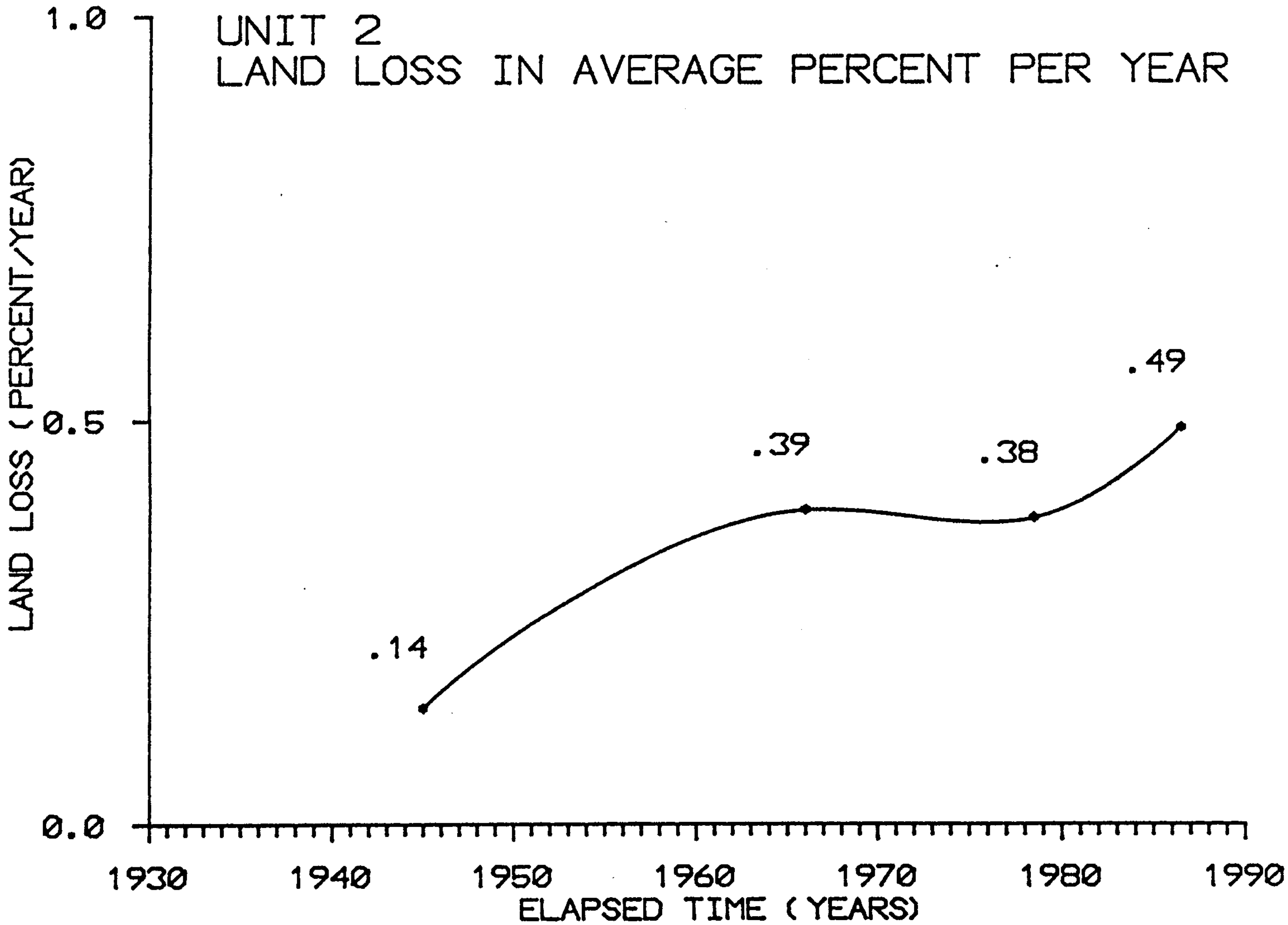
Unit 2 is located in the eastern portion of the Mississippi River deltaic plain. This Unit is comprised of brackish marshes in the western half and saline marshes in the eastern half. Dominant physiographic features include the natural levee of the Mississippi River, abandoned distributaries and their associated natural levees, Grand Lake and Lake Lery. Elevations range from approximately +5 feet NGVD on the natural levee bordering the Mississippi River to near 0 feet NGVD in the most seaward marshes.

Geologic profiles in the area show typical depositional environments of the deltaic plain. The upper Holocene sediments range from 100 feet thick near the Mississippi River to approximately 200 feet thick near Breton Island. Holocene sediments are composed of numerous abandoned distributaries and their associated natural levees separated by marsh deposits. Natural levee deposits are composed of oxidized clay and silty clay with minor amounts of silt and are up to 15 feet thick. Natural levees generally have higher compressive strengths and lower water contents than the surrounding environments making them less susceptable to erosion. Marsh deposits are composed of organic clays and peat having high water contents and obtain thicknesses of up to 12 feet. Natural levee and marsh deposits are underlain by interdistributary deposits composed of soft to very soft clays with minor amounts of silt having high water content. Interdistributary deposits range from 60 to 100 feet thick in Unit 2 and are underlain by prodelta deposits. Prodelta deposits are composed of medium clays with minor amounts of silt and range from 60 to 70 feet in thickness. Beneath the prodelta are nearshore gulf deposits approximately 10 feet thick composed of silts, sands, and shell. The Pleistocene surface underlies the nearshore gulf deposits. The depth to the Pleistocene ranges from approximately -100 feet NGVD near the Mississippi River to approximately -200 feet NGVD in the vicinity of Breton Island.

Long-term relative subsidence rates in Unit 2 average approximately 0.75 feet per century with rates of up to 4.0 feet per century in the extreme southwestern portion of the Unit.

### Historic Land Loss

The overall trend in land loss in Unit 2 since 1932 has been one of increasing rates. During the 1932 to 1958 period the



UNIT 2
LAND LOSS IN AVERAGE PERCENT PER YEAR
1.0
0.5
0.0
LAND LOSS ( PERCENT/YEAR)
.14
.39
.38
.49
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)


Figure 5.

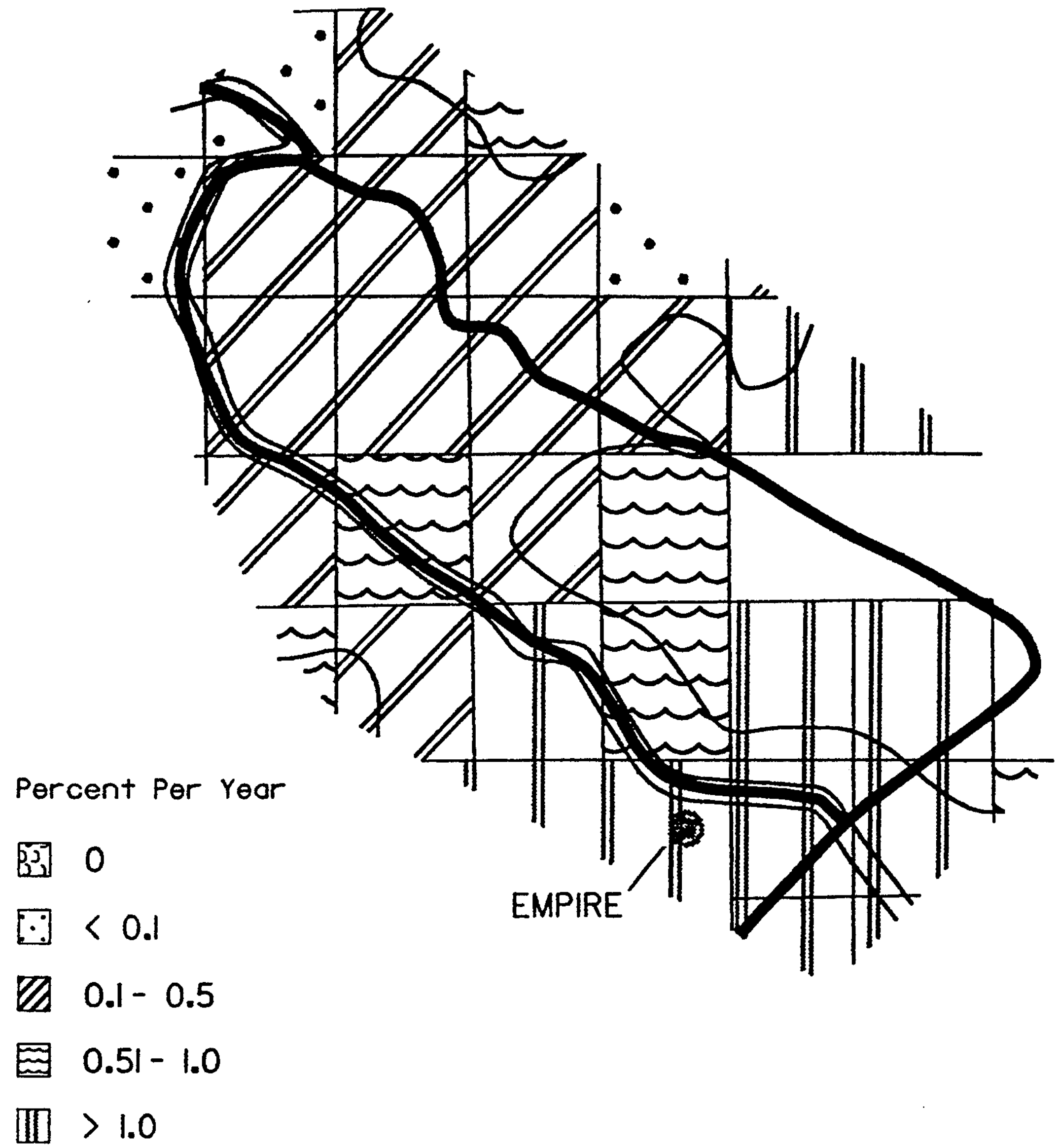



Figure 6. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

average annual land loss rate was 0.47 sq mi/yr. The rate increased to 1.25 sq mi/yr during the 1958 to 1974 period. The rate decreased slightly to 1.15 sq mi/yr during the 1974 to 1983 period but continued its long-term trend by increasing to 1.43 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 5). During the 1932 to 1958 period Unit 2 lost an average of 0.14 percent of its land area each year. This rate increased to 0.49 percent per year during the 1983 to 1990 period. By 1990 Unit 2 had lost approximately 16 percent of the land area present in 1932. Approximately 17 percent of the total loss was classified as direct man-made loss. Most of the direct man-made loss (87 percent) occurred between 1932 and 1974.

Figure 6 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles approximating Unit 2. This figure shows that percentage loss rates are relatively low in the northwestern portion of Unit 2 and increase to over 1 percent per year in the marshes bordering Breton Sound.

<u>Location of Historic Loss</u>

Some areas which have experienced high rates of interior marsh loss in Unit 2 include:

1. the marshes approximately 2 miles east and parallel to the Mississippi River between Braithwaite and Bertrandville
2. approximately 2 miles north and parallel to the Mississippi River near Nero
3. between Bay Denesse and Little Coquille Bay, north of Fort St. Philip

Some areas where shoreline erosion rates have been especially high include:

1. the southern and eastern shore of Lake Lery
2. the southeastern shore of Grand Lake
3. all of the islands located in Black Bay and Breton Sound
4. California and Spanish Points near California Bay
5. Sable Island, Raccoon, Fort, Coquille, and Deepwater Points, and Bird Island adjacent to Breton Sound.

Some sites where direct man-made loss has been relatively high include:

1. the marshes surrounding Lake Petit
2. the area due north of Pointe A La Hache
3. adjacent to the Mississippi River near Fort St. Philip

The available data suggests that the primary causes of land loss in Unit 2 are shoreline erosion, alterations to the natural surface hydrology, and direct man-made loss.

<u>Future Areas of Loss</u>

As shown previously, both the average square miles and percentage of land being lost each year has generally continued to increase during the 1932 to 1990 period. The overall rate of loss within Unit 2 should continue to increase slightly in the near future due to continued high loss related to shoreline erosion. However, at some point in the future, as the eroding shoreline moves inland, it will encounter a greater percentage of the more resistant natural levee deposits possibly resulting in a reduction in the shoreline erosion rate.

Some areas where lands loss rates will remain relatively high or increase slightly include:

1. The marsh shorelines bordering Black Bay and Breton Sound, especially where the shoreline protrudes into open water areas. At these points, wave and current energy is focused resulting in higher relative shoreline erosion rates.
2. The interior marshes approximately 2 miles east and parallel to the Mississippi River between Braithwaite and Bertrandville, and another area between the northeastern shore of Lake Lery and Bayou Terre Aux Boeufs. Altered surface hydrology appears to be responsible for much of the loss in both of these areas.
3. The marshes between Bay Denesse and Little Coquille Bay north of Fort St. Philip. High subsidence rates, shoreline erosion, and numerous man-made canals have all contributed to the high loss rates in this area.

Some areas where land loss rates have been relatively low but may increase are:

1. Sites where eroding lake or bay shorelines intersect isolated ponds or lakes in the adjacent marshes. This allows waves and currents to act directly on previously protected interior marshes. Grand Lake and Lake Petit located in the central portion of Unit 2 are examples of this situation.
2. Areas where man's activities combine with natural features to alter the surface hydrology possibly making them susceptible to marsh loss. One such area is located between Carlisle and River Aux Chenes near the Mississippi River. Their are numerous canals and levees (both man-made and natural) which appear to have altered the surface hydrology in this area. Land loss is already occurring within this area and may increase in the future.

Direct man-made loss in Unit 2 has decreased since 1974 and will probably continue to decrease.

## Permits

Four permits for marsh restoration have been issued within Unit 2 (see figure ?). As shown in figure ? the permitted areas

for permits 1, 2, and 48 are contiguous with each other. All three of the permitted areas have experienced relatively high rates of interior marsh loss between 1958 and 1974. Since 1974 the loss rate appears to have decreased except for the area covered by permit 48 where loss continues at a high rate. Land loss, subsidence, and geomorphic data suggests that alterations to the natural hydrology have contributed to the loss experienced in these areas. Several man-made canals and natural levees associated with abandoned distributaries have combined to alter the natural hydrology of these areas. Therefore, any projects designed for marsh restoration in these areas should consider the role which alterations to the natural hydrology have played in marsh loss. The fourth permitted area, #282, has experienced relatively high rates of land loss since 1958. Like the other permitted areas, man-made canals and the natural levees of the Mississippi River and River Aux Chenes have combined to alter the hydrology of this area contributing to land loss.

The three permitted areas in the northern portion of Unit 2 are wholly contained by a project proposed under CWPPRA. The stated purpose of the CWPPRA project is outfall management of storm water runoff pumped from the Forty Arpent Canal on the northern boundary of the area.

<u>CWPPRA</u>

The restoration plan developed under the CWPPRA for the Breton Basin summarized the existing conditions, identified the problem areas in the Basin, and proposed projects to address the problem areas. The Breton Basin closely approximates Unit 2 as defined by Chabreck, 1972.

As summarized from CWPPRA, the two major wetland problems resulting from natural processes and man's activities in the Basin are sediment deprivation and saltwater intrusion. Subsidence and shoreline erosion are important contributors to marsh loss in the lower Basin. Specific strategies for this Basin include managing existing freshwater diversions, building new large scale sediment diversions, rebuilding natural levee ridges, and creating artificial barriers.

There are no projects classified as marsh management proposed in the CWPPRA Plan. However, many of the projects proposed by CWPPRA would benefit many of the areas of loss mentioned previously.

The CWPPRA Plan estimates that approximately 13,380 acres (7.3%) of the Basin's existing marshes will be lost over the next 20 years without implementation of proposed projects. Much of the projected loss is anticipated to occur in the southern half of the Basin.

<u>Summary</u>

The average square miles and percentage of land being lost each year has generally continued to increase since 1932. Loss

rates are especially high in the southern half of this Unit where over 1 percent of the land area is lost annually at some locations. The overall rate of loss in Unit 2 should remain the same or increase slightly in the next 20 years. Shoreline erosion, alterations to the natural hydrology, and subsidence will continue to major contributors to future loss.

## Unit 4

### Location

Unit 4 encompasses the Barataria Basin and extends from the Mississippi River southward to the Gulf of Mexico. It has common boundaries with four other hydrologic units. It borders Unit 1 along its northern side, Unit 2 along its eastern side, Unit 3 at its southeastern corner, and Unit 5 along the western side (Fig. 1).

### Geologic Setting

Unit 4 is located in the central and southeastern portion of the Mississippi River Deltaic Plain. Inland swamp is common in the northern half of Unit 4 bordering the Mississippi River, Bayou Lafourche, and some of the larger abandoned distributaries. The northern half of the Unit also contains fresh and intermediate marsh. Much of this marsh is of the floating variety. Brackish and saline marshes make up the southern half of the Unit.

Dominant physiographic features include the Mississippi River, Bayous Lafourche, L'ours, des Allemands, des Familles, and Grande Cheniere and their associated natural levees. Also, the Barataria Waterway, Grand Isle, Grand Terre Islands, and numerous inland lakes such as des Allemands, Cataouatche, Salvador, and Little Lake. Elevations in Unit 4 range from approximately +10 feet NGVD on the natural levee bordering Bayou Lafourche, to +5 feet NGVD on Grand Isle to near 0 feet NGVD in the coastal marshes.

Typical geologic profiles in this Unit show the characteristic depositional environments of the deltaic plain. The upper Holocene sediments are relatively thin in the northern portion of this Unit and gradually increase in thickness towards the Gulf. Near Lac Des Allemands, Holocene sediments are approximately 50 feet thick and increase to approximately 350 feet thick near Leeville. The upper Holocene depositional environments include numerous abandoned distributaries and their associated natural levees separated by interdistributary, marsh,

and swamp deposits. Natural levees are generally composed of oxidized clay and silty clay having higher compressive strengths and lower water contents than the surrounding environments. Marsh deposits are composed of organic clays and minor amounts of silt, containing high amounts of organic debris and peat. Swamp deposits are clays with minor amounts of organic material having a medium consistency. Marsh and swamp deposits in Unit 4 reach thicknesses of approximately 10 feet. They are underlain by interdistributary deposits which consist of soft to very soft clays with minor amounts of silt reaching a thickness of approximately 90 feet. Prodelta deposits are located beneath interdistributary deposits and consist of medium clays with minor amounts of silts reaching thicknesses of up to 80 feet. Beneath the prodelta are nearshore gulf deposits composed of sand, silt, and shell material reaching thicknesses of 10 feet. Prodelta and nearshore gulf deposits are absent in the northern portion of Unit 4. The Pleistocene surface underlies interdistributary deposits in the northern portion of the Unit and nearshore gulf deposits in the southern portion. The depth to the Pleistocene surface is approximately -50 feet NGVD in the northern portion and gradually increases to -350 feet NGVD at the coast.

Long-term subsidence rates in Unit 4 average approximately 0.58 feet per century. Subsidence rates increase from north to south due to the increasing thickness of Holocene sediments above the stable Pleistocene surface.

Historic Land Loss

The average land loss rate for Unit 4 during the 1932 to 1958 time period was 2.66 sq mi/yr. The rate increased dramatically to 6.35 sq mi/yr during the 1958 to 1974 period and to 8.49 sq mi/yr during the 1974 to 1983 period. The rate decreased slightly to 7.37 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 7). The percentage loss rate increased from 0.15 percent per year during the 1932 to 1958 period to 0.51 percent per year during the 1974 to 1983 period. The percentage loss rate decreased slightly to 0.46 percent per year during the 1983 to 1990 period. By 1990, Unit 4 had lost approximately 16 percent of the land area present in 1932. Direct man-made loss accounted for approximately 17 percent of the total loss from 1932 to 1990. Most of the direct man-made loss occurred prior to 1974. Figure 8 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 4. This figure shows that the northern portion of Unit 4 is generally losing less than 0.1 percent per year. The central portion is losing between 0.1 and 1.0 percent per year and the southern portion from 0.51 to over 1.0 percent per year.

Location of Historic Loss

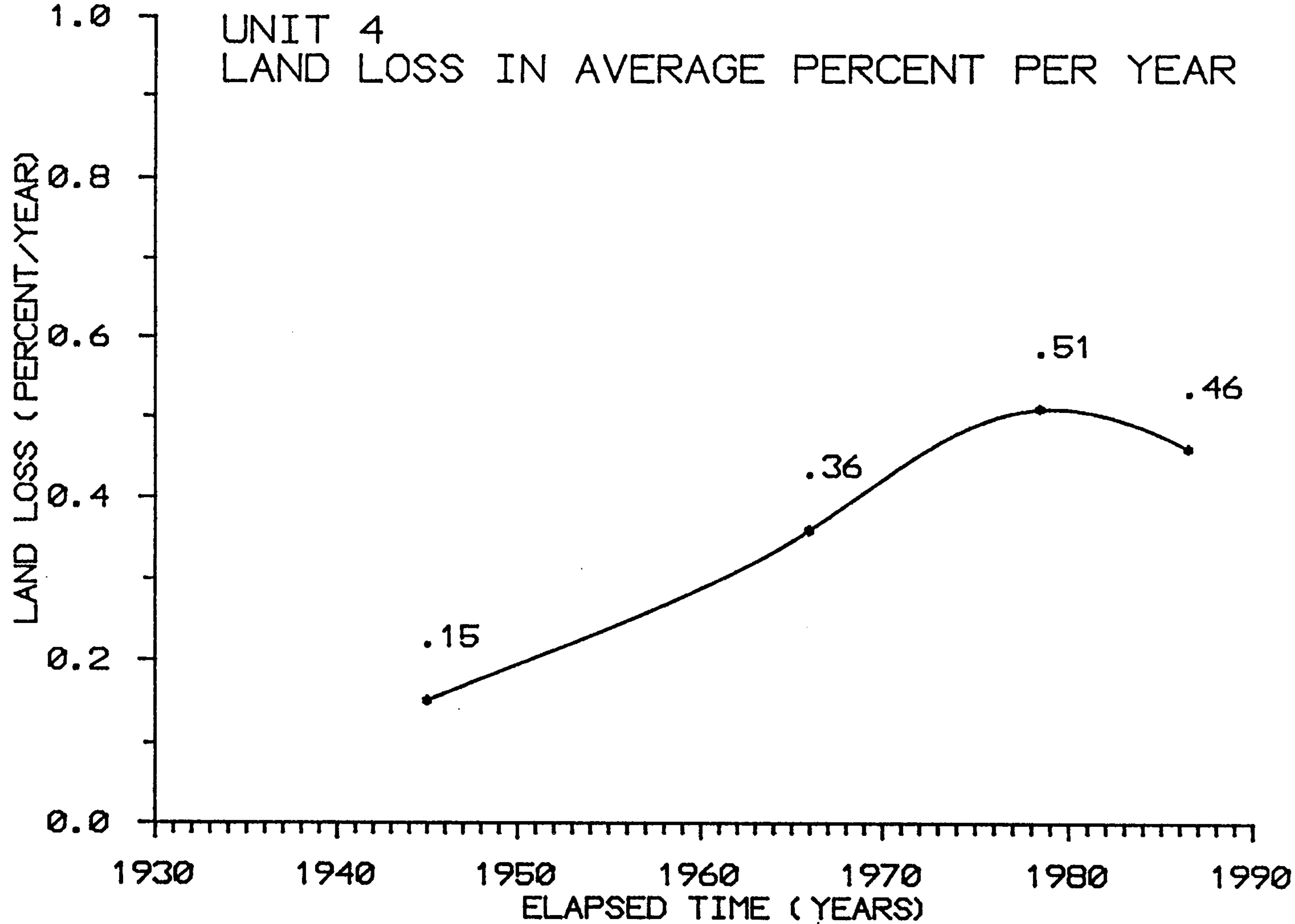

UNIT 4
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
.15
.36
.51
.46
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 7.

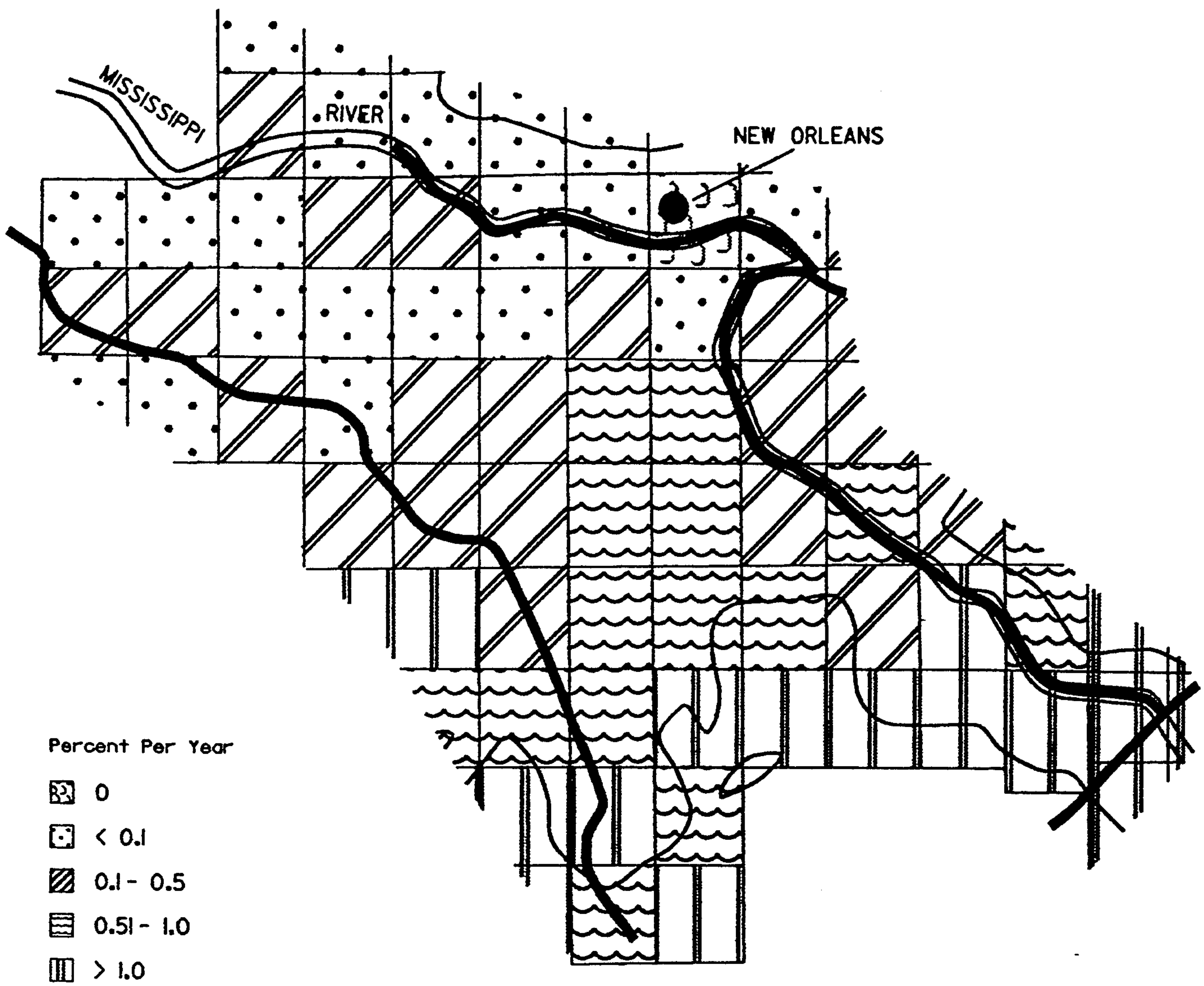



Figure 8. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

Some areas which have experienced high rates of interior marsh loss in Unit 4 include:

1. south of Lake Hermitage near Magnolia, near the Mississippi River
2. due west of Myrtle Grove near the Mississippi River
3. due west and northwest of Lake Cataouatche
4. south of Fort Jackson near the Mississippi River
5. between Bayous Perot and Rigolets near Lafitte
6. adjacent to the Barataria Waterway, south of Lafitte
7. east and west of Bastian and Adams Bay, south of Empire
8. just east of Bayou Lafourche from Leeville to just north of the Gulf shoreline
9. north and south of Bayou L'Ourse, southwest of Little Lake
10. southeast of Lake Grande Ecaille

The loss associated with areas 1, 2, 3, 5, 6, 8, and 9 appears to be related to alterations to the hydrology. In areas 4, 7, and 10, subsidence combined with alterations to the hydrology appear to be the main causes of loss.

Some areas where shoreline erosion rates have been particularly high include:

1. Pointe aux Herbes on Lac Des Allemands
2. the shoreline of Lakes Cataouatche and Salvador
3. the islands and points within and adjacent to Barataria Bay
4. the Gulf shoreline from Barataria Pass eastward to Bay Coquette
5. the shoreline of Catfish Lake east of Bayou Lafourche
6. the shoreline bordering Lakes Felicity and Raccourci
7. the Gulf shore from Belle Pass to just west of Caminada Pass
8. the shorelines adjacent to Bayous Perot and Rigolets
9. the shoreline adjacent to Little Lake

Some sites where direct man-made loss has been particularly high include:

1. near Leeville, west of Bayou Lafourche
2. east and west of Catfish Lake
3. between Lake Bully Camp and Bayou Lafourche
4. east of Lake Grande Ecaille
5. in the marshes adjacent to Adams and Bastian Bays
6. southeast of Lake Hermitage near Magnolia
7. north and west of Bayou Perot
8. east of the Barataria Waterway, south of Bayou Dupont
9. north and south of Delta Farms

The approximate date, location, and morphology of the land

loss provides insight into the major causes of loss. From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the CWPPRA Plan for the Barataria Basin, the primary causes of historic loss in Unit 4 appear to be alterations to the natural hydrology, shoreline erosion, subsidence, and direct man-made loss.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has increased in Unit 4 since 1932, except for a small decrease in the rate during the 1983 to 1990 period. Some areas where land loss rates will probably remain relatively high or increase include all the areas listed above as areas of interior and shoreline erosion under "Location of Historic Loss". In these areas the loss rates have been high for at least 20 years and their is no indication that the rates will not continue to be relatively high.

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. east of Lake des Allemands, east and west of Providence Canal
2. southeast of Crown Point between Bayou La Tour and the Mississippi River
3. between the Harvey Cutoff and the Barataria Bay Waterway
4. east and west of Grand Bayou just south of the Freeport Sulphur Co. Canal

At these sites, alterations to the natural hydrology may lead to an increase in the land loss rate.

5. Sites where the eroding lake shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from the lakes to act directly on previously protected interior marshes. This has, or will likely occur at the following locations:
   a. along the northwest shoreline of Lake Salvador
   b. Brusle Lake and Coffee Bay adjacent to Little Lake
   c. between Little Lake and the Barataria Bay Waterway
   d. north and south of Bay l'Ours near the southern end of Bayou l'Ours
   e. Bay Batiste and the bays to its northwest
   f. between Bayous Rigolettes and Perot

The direct man-made loss due to dredging activity in Unit 4 has decreased since 1974 and will probably continue to decrease.

Permits

Fourteen marsh management permits have been issued within Unit 4 (Fig. 4-4). Waterfowl management and marsh restoration

are the primary purposes stated for these projects. A lack of detailed information on each permitted area precludes a specific discussion of these areas. Therefore areas with similiar settings have been grouped and some general observations are provided.

The areas included in permit #'s 226, 480, 529, 110, 192, 718, and 229 have experienced high rates of interior marsh loss within the past 60 years. The areas covered by permit #'s 547, 517, and 577 have experienced high rates of man-made loss as well as interior loss. The loss that has occurred in all of these areas appears to be related to alterations to the natural hydrology. The interactions between man-made and natural geomorphic features has led to increased hydoperiods, tidal scour, and saltwater intrusion.

Areas included in permit #'s 540 and 215 have experienced high rates of man-made loss, but relatively little interior loss. Shoreline erosion has also been high at number 215. Although past interior loss in these areas has been relatively low, alterations to the natural hydrology already in place may lead to increased future loss if the proposed projects fail to address these alterations.

The areas covered by permits 107 and 733 have had little loss in the past 60 years. Alterations to the natural hydrology do exist at these sites which should be considered in any management plan.

## CWPPRA

The restoration plan developed under the CWPPRA for the Barataria Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Barataria Basin follows the same boundaries as Chabrecks' Unit 4. As summarized from CWPPRA, the primary causes of wetland loss in the Barataria Basin is attributed to a combination of natural and man-made causes, primarily due to a lack of sediments, relative subsidence, erosion, herbivory, channelization, levee construction, and development.

Specific planning objectives include restoring fluvial inputs, maintaining and restoring central basin marshes ,barrier islands, and fringe marshes, and reducing tidal exchange between the upper and lower basin. Figure 4-5 shows the locations of the proposed marsh management projects in Unit 4 from the CWPPRA Plan. Four of these projects have been partially or wholly permitted and are discussed somewhat under "Permits". All of the project areas proposed by CWPPRA have experienced high rates of land loss in the past 60 years. However, projects BA-6 and XBA-49 have experienced mainly direct man-made loss and minor interior loss rather than the high rates of interior loss common in the other project areas. Historic land loss and geomorphic data suggests that much of the interior marsh loss is related to

alterations to the natural hydrology, especially as it relates to increased tidal scour. The project strategies include creating barriers to reduce tidal exchange and increasing fresh water retention. These strategies should benefit these areas assuming that excessive water levels do not result.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that 76,160 acres (16.6%) of the Basin's existing wetlands would be lost to open water over the next 20 years without implementation of proposed projects.

Summary

In summary, both the square miles and percentage of land being lost annually in Unit 4 has continued at a high rate over the past 60 years. A large percentage of this loss has occurred in the middle and lower portions of the Unit. Shoreline erosion, alterations to the natural hydrology, relative subsidence, and direct man-made loss appear to be the major causes of loss in this Unit. The rate of loss will probably remain the same or decrease slightly over the next 20 years under existing conditions assuming a continued decrease in man-made loss and a small decrease in interior marsh loss.

## Unit 5

Location

Unit 5 has the largest marsh area and extends from Bayou Lafourche to the east levee of the Atchafalaya River (Fig.1).

Geologic Setting

Unit 5 is located in the south-central portion of the Deltaic Plain. This Unit is characterized by a complex network of abandoned distributaries and their associated natural levees separated by swamp and marsh deposits. Inland swamp is common in the northern portion of the Unit bordering Bayous Black and Lafourche and paralleling some of the larger abandoned distributary channels such as Bayous Dularge, Grand Caillou, and Terrebonne. Fresh and intermediate marsh is common in the northern half of the Unit. Much of this marsh is of the floating variety. Brackish and saline marshes make up the southern half

of the Unit with a large zone of saline marsh paralleling the coast.

Dominant physiographic features includes Bayous Black, Lafourche, DuLarge, Grand Caillou, Petit Caillou, Terrebonne, and Blue and their associated natural levees. Also, the Gulf Intracoastal Waterway, Houma Navigation Channel, Isles Derniere and Timbalier Island, and numerous inland lakes such as Decade, Mechant, and Boudreaux. Elevations in Unit 5 range from +10 feet NGVD on the natural levees bordering Bayous Black and Lafourche to near 0 feet NGVD in the marshes.

Typical geologic profiles in the area show a thick sequence of Holocene deltaic sediments underlain by Pleistocene deposits. Holocene sediments are composed of natural levee, swamp, and marsh deposits up to 40 feet thick adjacent to the major distributaries. These deposits are underlain by up to 180 feet of interdistributary deposits composed of soft to very soft clays with some silt lenses and shell material. Below the interdistributary deposits are substratum sands composed of silty sands with minor amounts of gravel. Substratum sands up to 200 feet thick are found in Unit 5. These sands are related to the Mississippi River Entrenchment which runs through Unit 5. Beneath the substratum sands is the Pleistocene surface. The Pleistocene is generally composed of oxidized stiff clay with minor amounts of silt and sand. In Unit 5 the Pleistocene surface elevation ranges from -120 feet NGVD to -400 NGVD feet. The Pleistocene surface varies with the depth of the Mississippi River Entrenchment.

The thick sequence of unconsolidated Holocene sediments in Unit 5 is responsible for the relatively high subsidence rates in this area of the Louisiana coast. The average subsidence rate for Unit 5 is 0.66 feet per century. Subsidence rates greater than 1.0 foot per century are common at many locations in Unit 5.

## Historic Land Loss

The average yearly land loss rate for Unit 5 was 1.93 sq mi/yr for the 1932 to 1956 period. The rate increased dramatically to 9.65 sq mi/yr during the 1956 to 1974 time period. The rate then decreased to an average of 7.74 sq mi/yr during the 1974 to 1983 period and continued to decrease to 5.78 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same trend (Fig. 9). The average percentage loss rate peaked at 0.62 percent per year during the 1956 to 1974 period. It began to decrease after that period and was 0.44 percent per year during the 1983 to 1990 time period. By 1990, Unit 5 had lost approximately 20 percent of the land area present in 1932. Direct man-made loss accounted for approximately 13 percent of the total loss from 1932 to 1990. Most of the direct man-made loss occurred prior to 1974. Figure 10 shows the average annual percentage of land being lost for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles

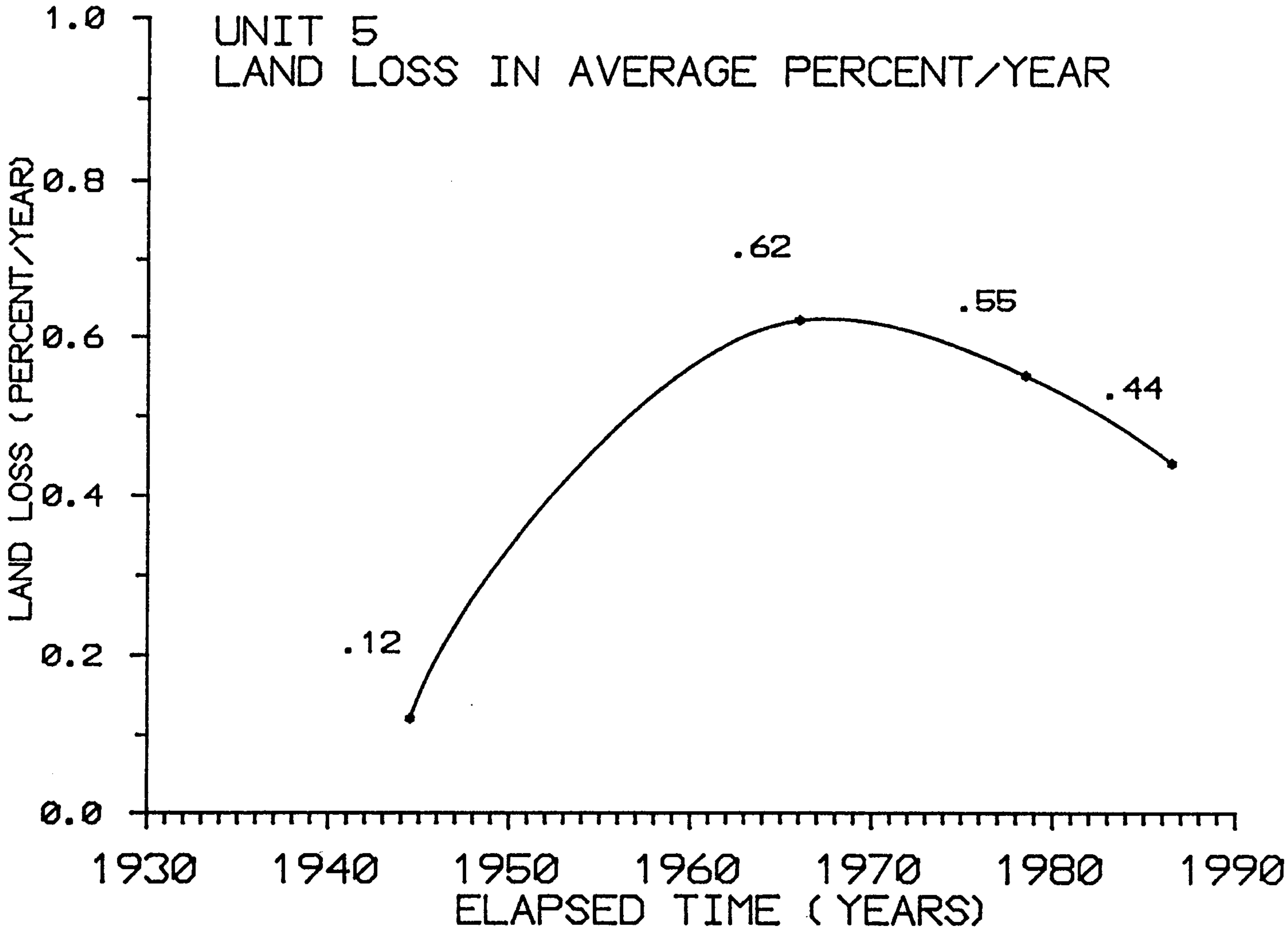

UNIT 5
LAND LOSS IN AVERAGE PERCENT/YEAR
LAND LOSS (PERCENT/YEAR)
1.0
0.8
0.6
0.4
0.2
0.0
.12
.62
.55
.44
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME (YEARS)

Figure 9.

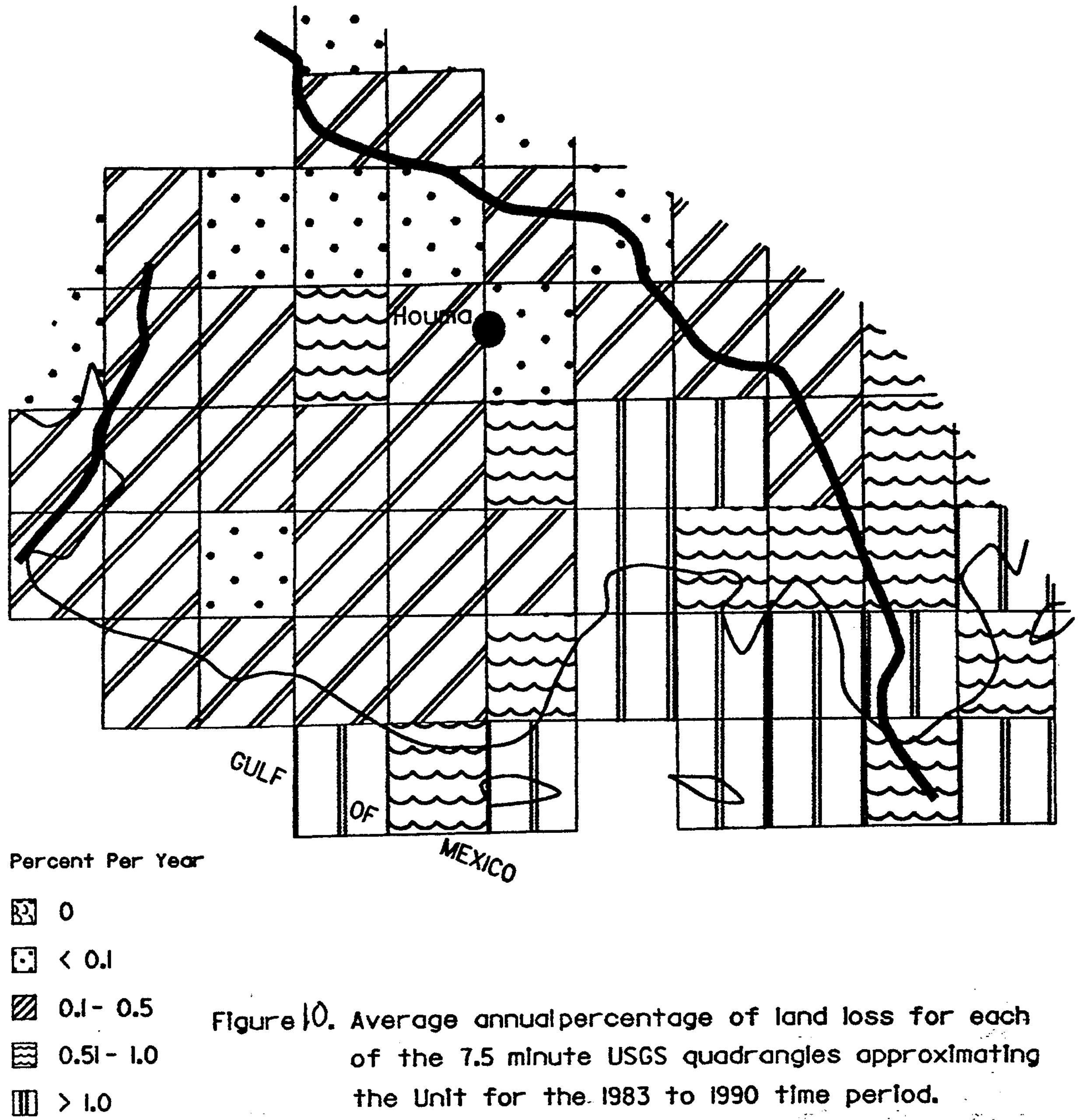



Figure 10. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

approximating Unit 5. This figure shows that the northern, western, and southwestern portions of Unit 5 are generally losing less than 0.5 percent per year while the eastern and south-eastern portions are generally losing 0.51 to over 1.0 percent per year.

Location of Historic Loss

Some areas which have experienced high rates of interior marsh loss in Unit 5 include:

1. Avoca Island
2. between Turtle Bayou and Bayou Copasaw, north of Bayou Penchant
3. east of Bayou Copasaw, south of the Intracoastal Waterway
4. between Lake Cocodrie and Hanson Canal, north of the Intracoastal Waterway
5. east and west of Carencro Bayou
6. the central portion of Point Au Fer Island
7. between Lost Lake and Lake Decade
8. north and south of Falgout Canal between Lake Decade and the Houma Navigation Canal
9. north of Lake Boudreaux, east and west of Bayou Chauvin
10. between Bayou's Terrebonne and Petit Caillou, along Bayou la Cache
11. adjacent to Madison Bay
12. adjacent to Wonder Lake
13. between Bayou Pt au Chien and Bayou Lafouche in the vicinity of Lake Bully Camp
14. east and south of Catfish lake

The loss in all of these areas, except 1, appears to be related to alterations in the hydrology, especially those which increase tidal scour. Area 1 is the site of a failed reclamation in which drainage-induced subsidence has led to land loss.

Some areas where shoreline erosion rates have been especially high include:

1. South Point, adjacent to Fourleague Bay
2. Pt au Fer
3. southwest shore of Lost Lake
4. east shore of Lake Decade
5. Isles Dernieres and Timbalier and East Timbalier Islands
6. Lake Boudreaux shoreline
7. along the marshes and islands bordering Lakes Barre, Felicity, and Raccourci and Pelto, Timbalier, and Terrebonne Bays
8. the banks of the Houma Navigation Canal and the Intracoastal Waterway
9. the banks bordering Avoca Cutoff, Bayou Chene, and Bayou Penchant

Some sites where direct man-made loss has been relatively high include:

1. east and west of Catfish Lake

2. the vicinity of Wonder Lake
3. north of Lake Bully Camp
4. the vicinity of Hackberry Lake, adjacent to Bayou Grand Caillou
5. the Houma Navigation Canal
6. the vicinity of Turtle Bayou
7. north and south of the Intracoastal Waterway from Hanson Canal to Lake Cocodrie
8. between Bayou Penchant and Carencro Lake

From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) and information published in the CWPPRA Plan for the Terrebonne Basin, the primary causes of historic land loss in Unit 5 appear to be alterations to the natural hydrology, shoreline erosion, and direct man-made loss.

Future Areas of Loss

As shown previosly, both the square miles and percentage of land being lost in Unit 5 has decreased substantially since the 1958 to 1974 period. However, even with this decrease, Unit 5 is losing land at a rate of almost 6 sq mi/yr. The main reason for this decrease was the reduction in interior marsh loss since 1974; especially in the Penchant subbasin.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. all of the areas of historic shoreline erosion listed previously
2. Avoca Island
3. northeast of Lake Cocodrie
4. between Lost Lake and Lake Decade
5. south of Falgout Canal between Bayou du Large and the Houma Navigation Canal
6. in the vicinity of Madison Bay
7. between Wonder Lake and Bayou Lafourche
8. east and south of Catfish Lake
9. north of Lake Boudreaux, east and west of Bayou Chauvin

Some areas where land loss rates have been relatively low but may increase in the near future include:

1. Areas where the eroding shorelines have intersected or will likely intersect isolated ponds and small lakes. This allows waves and currents from large water bodies to act directly on previously protected interior marshes. This is occurring throughout the southern half of Unit 5.
2. Areas where alterations to the hydrology exist that may cause loss rates to increase. Sites where this may occur include:
   a. south of Bayou Blue, west of Grand Bayou Canal

b. between Little Lake and Bayou Lafourche

c. south of Lake Decade between Bayou la Pointe and Bayou du Large

The direct man-made loss due to dredging activity in Unit 5 has decreased since the 1958 to 1974 period and will probably continue to decrease.

Permits

Thirteen marsh management permits have been issued within Unit 5 (Fig. 5-4). Waterfowl management and marsh restoration are the primary purposes stated for these projects. Permit #'s 870, 628, 625, 83, 696, and 943 have experienced high rates of interior and man-made land loss. Permit #'s 991, 478, the southern half of 2, and 146 are characterized by high rates of interior land loss. Alterations to the hydrology appear to be responsible for much of the loss in these areas except for #146 where drainage-induced subsidence is the main cause of past loss. In Unit 5, alterations to the hydrology result in an increase in the duration of flooding, tidal scour, and salt water intrusion as well as other processes that may lead to land loss. Therefore, any projects proposed in these areas should consider the role that alterations to hydrology have played in the loss rates. Permit #'s 703 and 169 have experienced relatively little past loss. However, alterations to the hydrology do exist at #169. Permit #953 has experienced high rates of shoreline erosion. Nine of the 13 previously permitted projects are wholly or partially contained on the CWPPRA list of proposed projects.

CWPPRA

The restoration plan developed under the CWPPRA for the Terrebonne Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. As summarized from CWPPRA, the primary causes of wetland loss in the Terrebonne Basin are hydrologic alterations, salt water intrusion, subsidence, and loss of barrier islands. The key planning objectives were: 1) restoration of fluvial inputs of sediment and water; 2) presevation of existing marsh in the Timbalier, Penchant, and Fields Subbasins; and 3) restoration of hydrologic conditions conducive to cypress regeneration in the Verret Subbasin.

Figure ? shows the location of the proposed marsh management projects in Terrebonne Basin from the CWPPRA Plan. All of the projects proposed by CWPPRA are characterized by relatively high rates of interior marsh loss except for #'s XTE 47/48 and PTE 22/24 which have experienced only moderate loss. Also, #XTE-28, the parish line of defence, a regional project which does include some areas of interior loss, generally covers the upper, central portion of the Basin where overall loss rates are relatively low. Most of the proposed projects are confined to an east-west band

of fresh (much of it floating), intermediate, and brackish marshes in the central and northern parts of the Basin. These marshes appear to be extremely sensitive to changes in the hydrology; especially those that increase the duration of flooding, allow salt water intrusion, and increase tidal scour. This is evidenced by the fact that prior to 1956, when man-made alterations to the hydrology were relatively minimal, the loss rate in Terrebonne Basin was 2.32 sq mi/yr. By 1974, when mans activities were near a maximum, the loss rate accelerated to 9.34 sq mi/yr. Alterations to the natural hydrology of this Basin are responsible for a large percentage of the interior marsh loss which has occurred. Shoreline erosion and direct man-made loss are also big contributors to land loss in this Basin.

The general concepts of the projects proposed for this Basin are better use of sediments and fresh water and reduction of tidal exchange and salt water intrusion. The projects proposed by CWPPRA should benefit the Basin as long as the ability to remove excess water within project boundaries is possible.

In addition to those projects classified as marsh management, CWPPRA has proposed numerous projects that address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that approximately 87,800 acres (14.4%) of loss will occur over the next 20 years if no restoration action is taken. Most of the loss will be concentrated in the Timbalier Subbasin.

<u>Summary</u>

In summary, both the square miles and percentage of land being lost annually in Unit 5 continues at a high rate and will probably remain high over the next 20 years. As shown in Figure 10, during the 1983 to 1990 period the southeastern portion of the Unit generally lost 0.5 to over 1.0 percent of its land area each year. The remaining portion of the Unit generally lost 0.5 percent or less of its land area. Shoreline erosion and alterations to the hydrology will probably continue to be the major causes of loss in Unit 5.

## UNIT 6

<u>Location</u>

Unit 6 is the smallest hydrologic unit and includes primarily the marsh area between the Atchafalaya River and Wax Lake Outlet (Fig. 1).

Geologic Setting

Unit 6 is located in the southwestern portion of the Mississippi River Deltaic Plain. This Unit is comprised of inland swamp in the northern half of the Unit and fresh marsh in the southern half. Dominant physiographic features include Bayou Teche and its associated natural levees, abandoned distributaries of the Teche Delta, the Atchafalaya River, and Belle Isle Dome. Elevations generally range from +10 feet NGVD on the natural levees bordering Bayou Teche to near 0 feet NGVD in the southernmost marshes. Elevations reach +75 feet NGVD on the Belle Isle Dome.

Typical geologic profiles in the area show characteristic depositional environments of the Deltaic Plain. The upper Holocene sediments are generally less than 50 feet thick except in the extreme northern and eastern portion of the Unit where the western side of the Mississippi River entrenchment begins. Holocene sediments in this portion of the entrenchment reach 200 feet in thickness. Outside the entrenchment the Holocene sediments are generally composed of up to 20 feet of marsh and swamp deposits overlying approximately 30 feet of interdistributary deposits. Natural levee deposits up to 30 feet thick border Bayou Teche. Marsh deposits are composed of highly organic clay and peat. Swamp deposits are generally soft to medium clay with minor amounts of silt and organics. Interdistributary deposits are composed of very soft clays with minor amounts of silt. Natural levee deposits are medium to firm clays and silts having lower water contents and higher compressive strengths than the surrounding environments. The Holocene deposits are underlain by the Pleistocene at a depth of approximately -60 feet NGVD.

In the Mississippi River entrenchment; marsh, swamp, and interdistributary deposits are underlain by sands and gravels down to the Pleistocene surface at approximately -200 feet NGVD. The thick sequence of marsh and swamp deposits in Unit 6 is indicative of the stability of this area relative to deltaic progradation. Prior to the recent influx of sediment from the Atchafalaya River, this Unit had received no major influx of riverine sediments since the Teche Delta was active in this area approximately 4000 years before present. This allowed marsh and swamp deposits to develop virtually uninterrupted during this period.

The close proximity of the Pleistocene surface in most of this Unit, coupled with accretion resulting from Atchafalaya River sedimentation, is responsible for the relatively low subsidence rate in this Unit. Long-term relative subsidence rates in Unit 6 average approximately 0.34 feet per century. Relative subsidence rates in the extreme northern and western portion of the Unit are over 0.50 feet per century due to the thick sequence of unconsolidated sediments in the Mississippi River entrenchment. However, active sedimentation from the Atchafalaya River has been able to balance these relatively

higher subsidence rates.

Historic Land Loss

The average land loss rate for Unit 6 was 0.21 sq mi/yr during the 1931 to 1956 period. The rate increased to 0.28 sq mi/yr for the 1956 to 1974 period, then decreased to 0.15 during 1974 to 1983 and 0.12 during the 1983 to 1990 period. The higher loss rate in the first two time periods is largely the result of direct man-made loss which accounted for approximately 39 percent of the total during these two periods. The natural land loss rate has been relatively stable throughout all four time periods, showing only a slight decrease since 1974. The average annual percentage of land being lost has followed the same trend (Fig. 11). It peaked at 0.20 percent per year during the 1956 to 1974 period and decreased to 0.09 percent per year during the 1983 to 1990 period. By 1990, Unit 6 had lost approximately 9 percent of the land area present in 1932.

Two main factors are responsible for the relatively low land loss rate in Unit 6:

1. Sediment and fresh water input from the Atchafalaya River.
2. The relatively shallow depth of the Pleistocene surface resulting in relatively lower subsidence rates.

Figure 12 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute USGS quadrangles approximating Unit 6. This figure shows that rates are less than 0.1 percent per year for most of Unit 6.

Land accretion is occurring mainly in Atchafalaya Bay at the mouths of the Atchafalaya River and Wax Lake Outlet and along Wax Lake Outlet and the Atchafalaya River.

Location of Historic Loss

Some areas which have experienced high rates of shoreline erosion in Unit 6 include:

1. the Bay shoreline from Wax Lake Outlet to the Atchafalaya River
2. along the Gulf Intracoastal Waterway
3. along the Lower Atchafalaya River, south of Sweet Bay Lake

Sites where direct man-made loss has been relatively high include:

1. the marshes in the vicinity of Belle Isle
2. west of the Atchafalaya River,east of Big Willow Bayou
3. on Bateman Island

Interior marsh loss has been relatively low in Unit 6. The primary causes of land loss in Unit 6 appear to be shoreline erosion and direct man-made loss from dredging.

## Future Loss Trends

Areas where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline from Wax Lake Outlet to the Atchafalaya River
2. The interior marshes between Big Willow Bayou and the Atchafalaya River, and the interior marshes of Bateman Island. In these areas man-made alterations to the hydrology may lead to an increase in the interior marsh loss occurring in these areas.
3. the shoreline of Lower Atchafalaya River south of Sweet Bay Lake

An area where land loss rates have been relatively low but may increase in the future is found in the vicinity of Belle Isle. In this area, a dense network of canals has led to alterations in the surface hydrology making the area susceptible to interior marsh loss.

The direct loss due to dredging activity in Unit 6 has decreased since 1974 and will probably continue to decrease.

## Permits

There are no marsh management permits in Unit 6 at this time.

## CWPPRA

There are no marsh management projects proposed in the CWPPRA Plan for the Atchafalaya Basin. The Atchafalaya Basin closely approximates Unit 6 except for the the area between Wax Lake Outlet and Bayou Sale which is not contained in Unit 6.

## Summary

Direct man-made loss has accounted for approximately 35 percent of the total loss in Unit 6 since 1931. If man-made loss was excluded, the land loss rate would have remained relatively stable during the 1931 to 1990 period.

As shown in Figure 12, the majority of Unit 6 lost less than 0.1 percent of its land area each year during the 1983 to 1990 period.

The overall rate of loss in Unit 6 should continue to decrease slowly assuming the continued decline in direct man-made loss, and continued sediment influx from the Atchafalaya River.

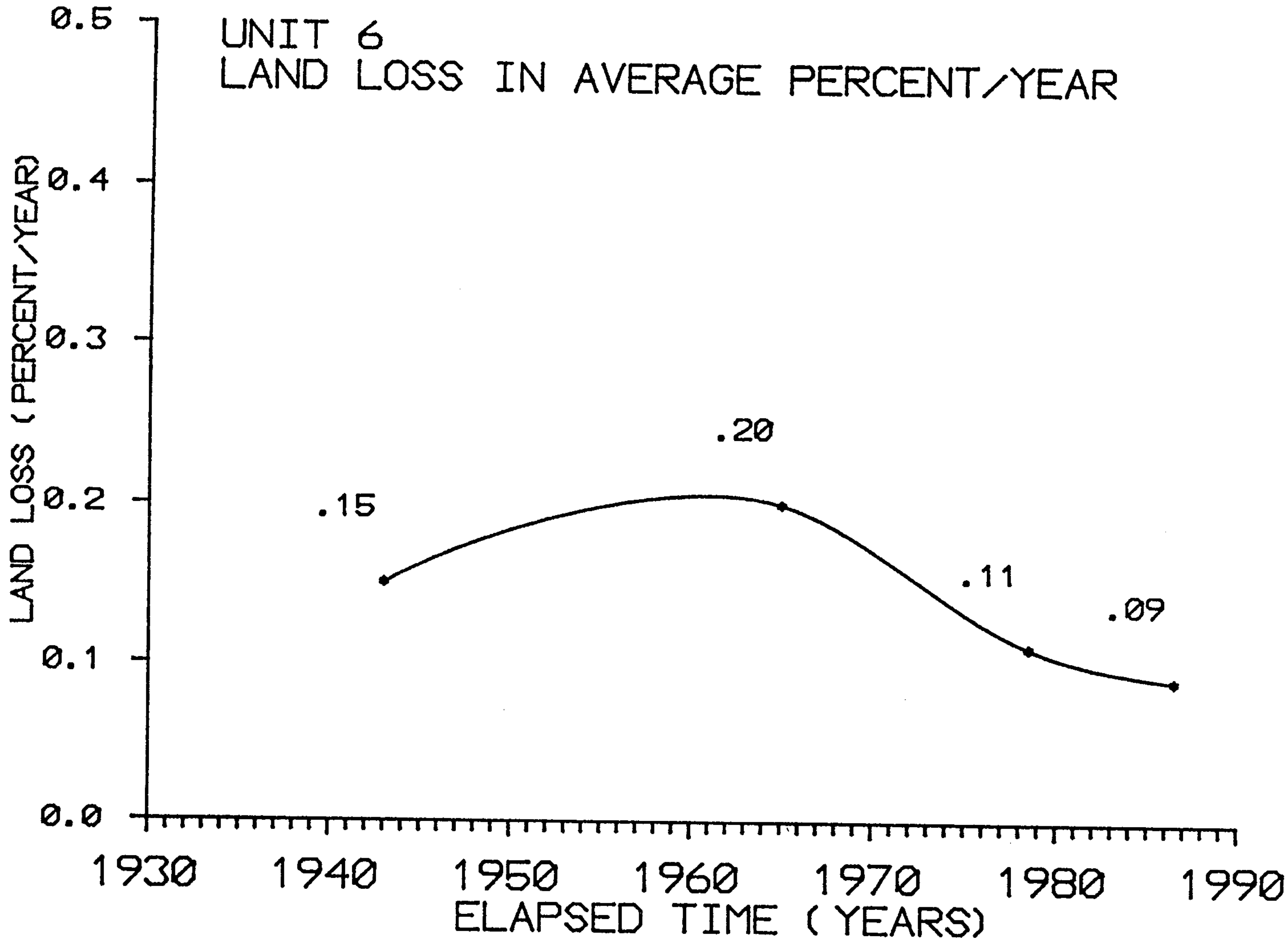

UNIT 6
LAND LOSS IN AVERAGE PERCENT/YEAR
LAND LOSS ( PERCENT/YEAR)
0.0
0.1
0.2
0.3
0.4
0.5
.15
.20
.11
.09
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)

Figure 11.

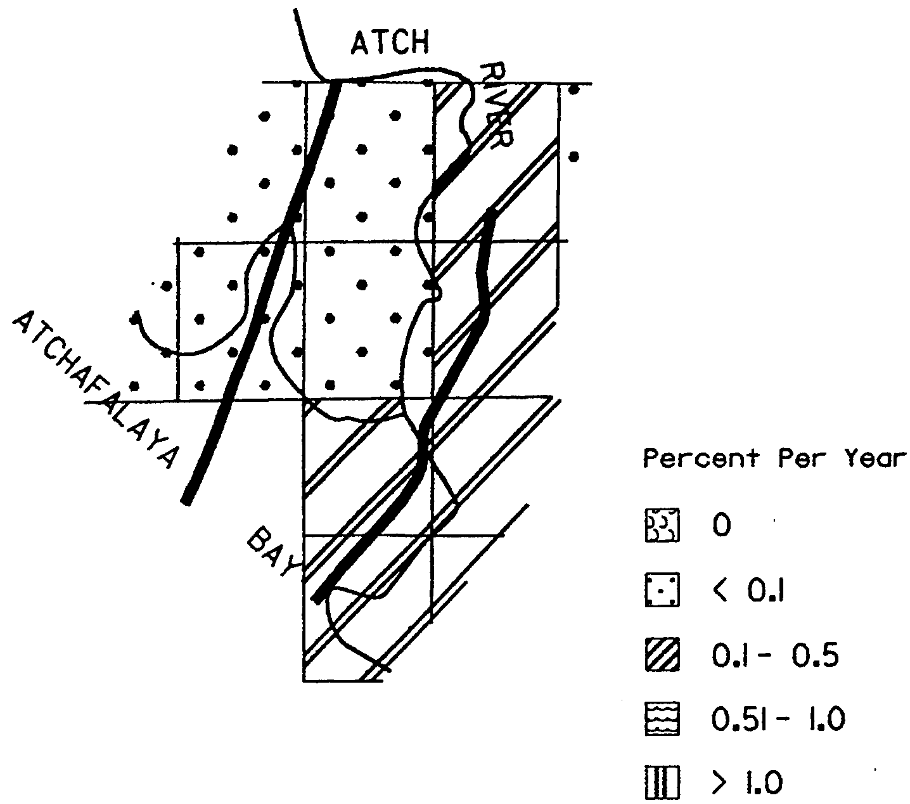



Figure 12. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

## Unit 7

### Location

Unit 7 includes Marsh Island, Vermilion Bay, East and West Cote Blanche Bays, and the marshes that surround these bays. The eastern boundary is Wax Lake Outlet. The western boundary lies along a line beginning at the Gulf of Mexico in Vermilion Parish about 5 miles west of the mouth of Freshwater Bayou Gulf Outlet. From this point the line trends northeast to the Schooner Bayou Control Structure and the Vermilion Locks, then north to the northern boundary of the coastal marsh (Fig. 1).

### Geologic Setting

Unit 7 is located partially in the extreme eastern portion of the Chenier Plain and partially in the extreme western portion of the Deltaic Plain. This unit is comprised predominantly of brackish marshes in the western half and fresh marshes in the eastern half. The influence of the Atchafalaya River to the east of Unit 7 is responsible for the large expanse of fresh marsh in the eastern half of Unit 7. Inland swamp is common between the Pleistocene outcrops on the north and the coastal marshes.

Dominant physiographic features include Marsh Island, Vermilion, West Cote Blanche, and East Cote Blanche Bays, Jefferson Island, Avery Island, Weeks Island, and Cote Blanche Island salt domes, and Bayous Cypremort and Sale, which are abandoned distributaries of the Teche Delta. Elevations are generally at marsh level except for the natural levees bordering Bayous Teche, Cypremont, and Sale, the Pleistocene outcrops, and the salt domes common in the area. Elevations up to +15 feet NGVD are found adjacent to Bayou Teche and on the Pleistocene surface, and may exceed +100 feet NGVD at the salt domes.

Typical geologic profiles in the area show the characteristic depositional environments of the deltaic plain. The upper Holocene sediments are generally less than 50 feet thick. The Holocene is composed of numerous abandoned distributaries and their associated natural levees separated by marsh and swamp deposits. The natural levees are composed of oxidized clay and silty clay with minor amounts of silt. Natural levees generally have higher compressive strengths and lower water contents than the surrounding environments making them less susceptible to erosion. Swamp deposits are composed of soft to medium clay with some organics. Marsh deposits are composed of organic clays with high amounts of organic debris and peat. Swamp and marsh deposits in Unit 7 are up to 20 feet thick. They are underlain by interdistributary deposits composed of soft to very soft clays with minor amounts of silt, and have high water

content. The interdistributary sediments continue down to the Pleistocene surface which is approximately -50 feet NGVD at Marsh Island and decreases inland where it outcrops south of Bayou Teche.

The thick continuous sequence of marsh and swamp deposits is indicative of the fact that Unit 7 has received no major influx of riverine sediments since the Teche Delta was active in this area approximately 4000 years before present. The close proximity of the Pleistocene surface is responsible for the relatively low subsidence rates in this Unit which have allowed the accretion of marsh and swamp deposits to generally keep pace with subsidence. Long-term subsidence rates in Unit 7 are approximately 0.43 feet/century.

Also, since the 1950's an increasing amount of sediment has reached Unit 7 from the Lower Atchafalaya River and Wax Lake Outlet which has helped this area maintain marsh elevation.

Historic Land Loss

The land loss rate for Unit 7 has remained relatively stable since 1932. The average rate was 0.84 sq mi/yr during the 1932 to 1951 period. It peaked at 2.03 sq mi/yr during the 1951 to 1974 period, then decreased to 1.27 sq mi/yr for the 1974 period to 1983 period. The rate increased slightly to 1.51 sq mi/yr during the 1983 to 1990 period. The average annual percentage of land being lost has followed the same pattern. It peaked at 0.24 percent during the 1951 to 1974 period and decreased to 0.19 percent per year for the 1983 to 1990 period (Fig. 13). By 1990, Unit 7 had lost approximately 9 percent of the land area present in 1932. Since 1932, the land loss rate for Unit 7 since 1932 has been relatively low when compared to most of the other hydrologic units in coastal Louisiana. Several factors contribute to this reduced rate of loss:

1. Sediment and fresh water input from the Atchafalaya River located east of Unit 7.
2. The shallow depth of the Pleistocene surface (<50 feet) which accounts for a lower relative subsidence rate as compared to other areas in the deltaic plain.
3. The reduced amount of direct man-made loss relative to other areas along the coast.
4. The high percentage of natural levee and swamp deposits in this Unit related to abandoned distributaries of the Teche Delta which are more resistant to erosion than marsh deposits.

As shown in Figure 13, the highest loss rate occurred during the 1951 to 1974 period which is common for most of coastal Louisiana. Direct man-made loss accounted for approximately 20 percent of the total loss from 1932 to 1990. Figure 14 shows the average annual percentage of land loss for the 1983 to 1990 period for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 7. This figure shows that rates

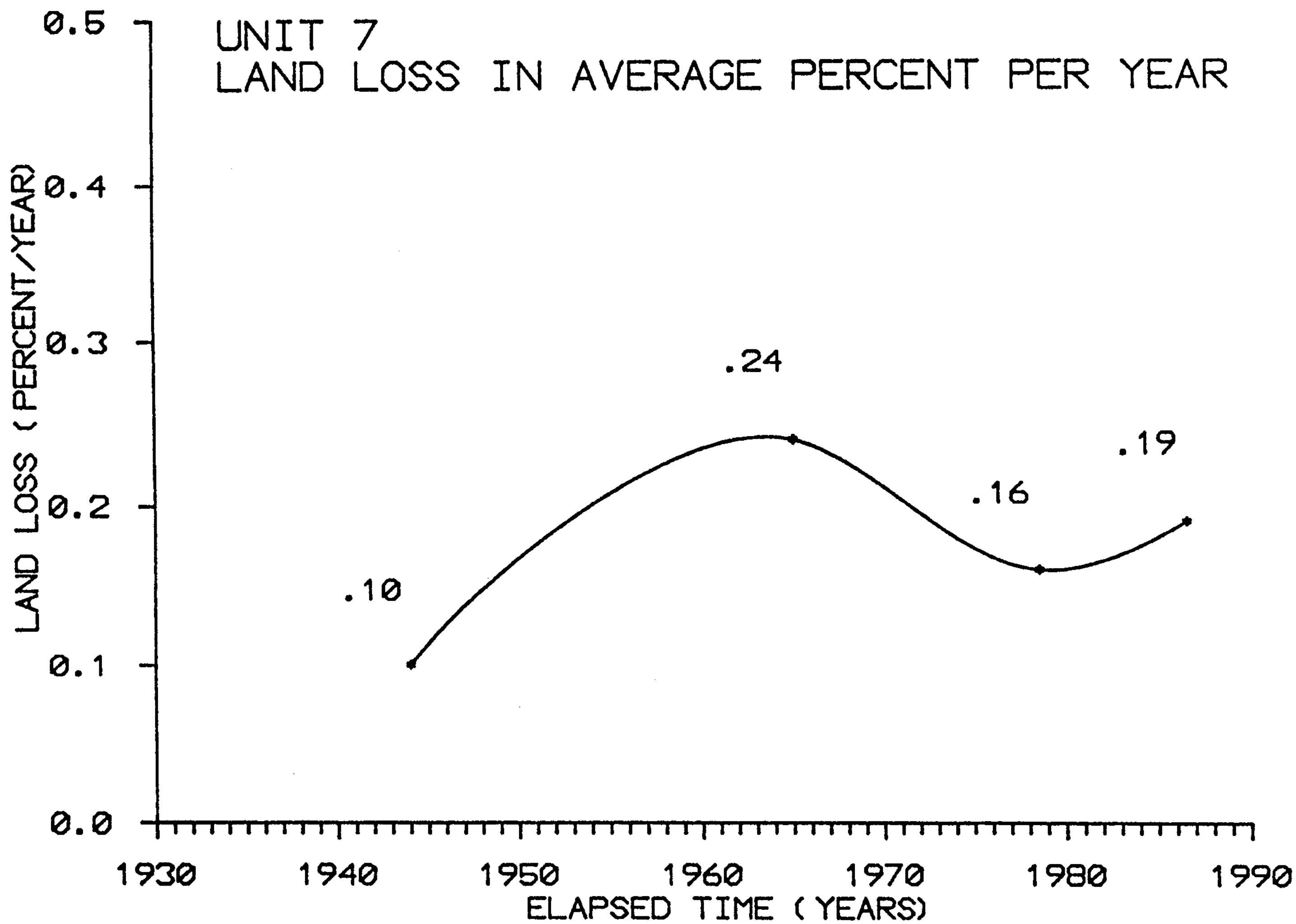

UNIT 7
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS ( PERCENT/YEAR)
0.5
0.4
0.3
0.2
0.1
0.0
.10
.24
.16
.19
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)

Figure 13.

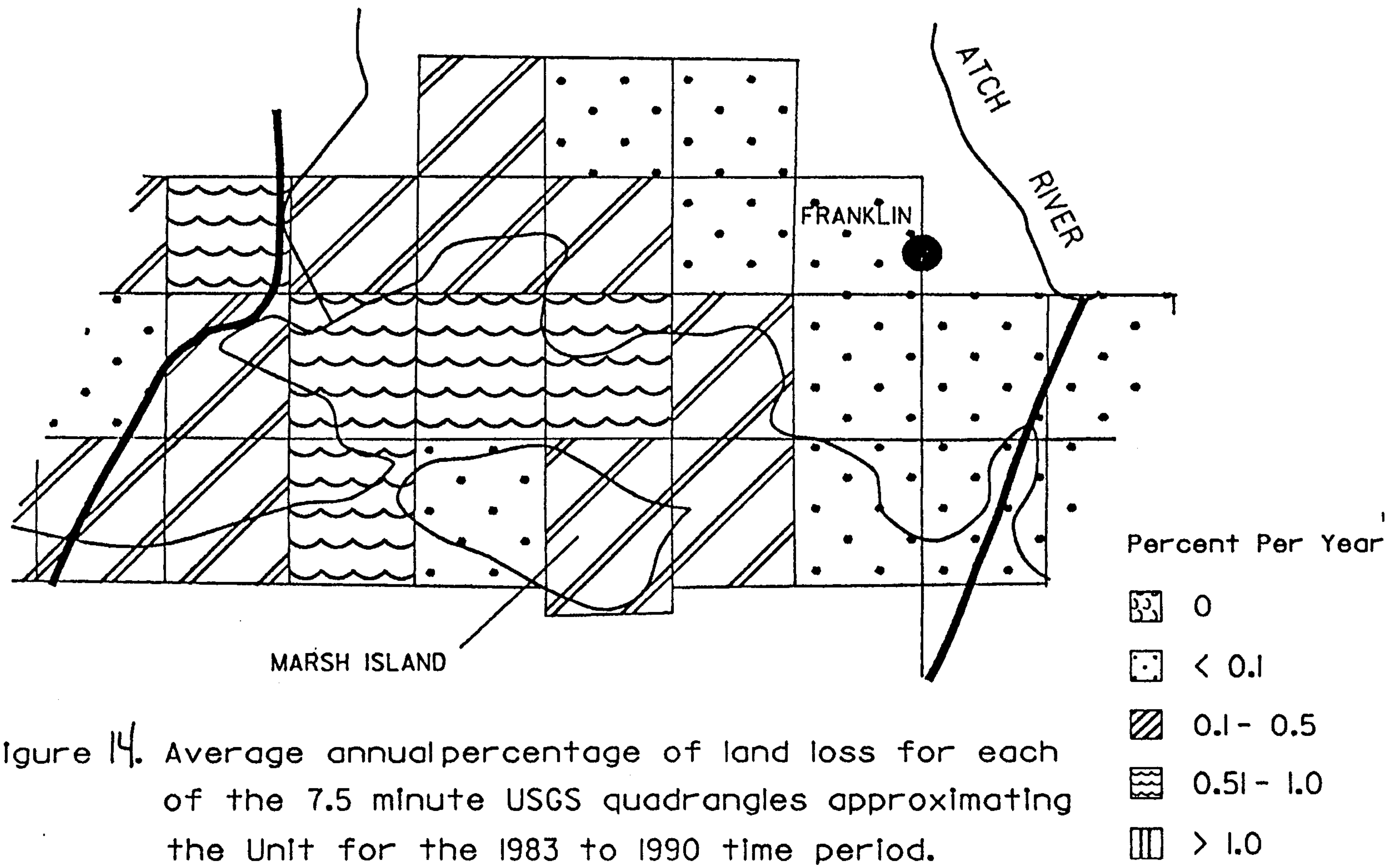



Figure 14. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

are generally less than 0.5 percent per year except for 4 quadrangles bordering Vermilion Bay and the Gulf where rates are between 0.5 and 1.0 percent per year.

Locations of Historic Loss

Some areas which have experienced high rates of interior marsh loss in Unit 7 include:

1. east of Intracoastal City on the north and south side of the Gulf Intracoastal Waterway (GIWW)
2. northeast of Marone Point,
3. in the central portion of Marsh Island
4. east of McIlhenny Canal in the Paul J. Rainey Wildlife Sanctuary

Some areas where shoreline erosion rates have been especially high include:

1. along the GIWW, Schooner Bayou and Vermilion River Cutoffs
2. at the mouth and east of Freshwater Bayou Canal
3. the north and southeast shore of Marsh Island
4. Lake, Marone, Blue, Pelican, and Lighthouse Points and Point Chevreuil
5. the shoreline from Dead Cypress Point to Cote Blanche Island
6. south of Bayou Petite Anse on the north shore of Vermilion Bay

Some sites where direct man-made loss has been relatively high include:

1. the marshes surrounding Weeks Island
2. adjacent to the east side of Bayou Sale from Ellerslie to the Gulf
3. north of the Intracoastal Waterway between Mud Lake and Bayou Sale
4. between the Intracoastal Waterway and Marone Point, west of Bayou Sale

From the available data sets (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of historic land loss in Unit 7 appear to be shoreline erosion, direct man-made loss, and alterations to the natural hydrology.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has remained relatively stable between 1932 and 1990. The main reason for this stability is the fact that shoreline erosion accounts for a large percentage of the total

loss in Unit 7. Because shoreline erosion is predominantly a natural process, the rates tend to be relatively constant over time.

Some areas where land loss rates will probably remain relatively high or increase slightly include:

1. all of the shoreline areas identified previously under "Location of Historic Loss"

2. east of Intracoastal City, north and south of the Intracoastal Waterway

3. east of McIlhenny Canal in the Paul J. Rainey Wildlife Sanctuary

In the areas identified in 2 and 3, alterations to the hydrology appear to be related to marsh loss.

Some areas where land loss rates have been relatively low but may increase include sites where the eroding bay shorelines intersect isolated lakes or ponds in the interior marshes. This allows waves and currents from the bays to act directly on previously protected interior marshes. This has or may occur at Lake Cock, located approximately 7 miles east of Vermilion River Cutoff; North Lake, located near the western shore of Vermilion Bay; Hammock Lake near Dead Cypress Point; and Lake Tom and Lake Sand in the northeast portion of Marsh Island.

Land loss rates may also increase at sites where man's activities have led to alterations in the surface hydrology making them susceptable to marsh loss. This may occur north of the Intracoastal Waterway between Mud Lake and Bayou Sale and east of Bayou Sale in the vicinity of Horseshoe Bayou.

The direct man-made loss due to dredging activity has decreased since 1974 and will probably continue to decrease.

Permits

Ten marsh management permits have been issued within Unit 7 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects. All of the permitted areas except for #'s 1 and 84 have experienced relatively high rates of land loss over the past 60 years. Man-made loss is also common in most of the permitted areas. Land loss appears to be continuing in these areas. Man-made alterations to the hydrology (usually in the form of access canals and their associated levees) in conjunction with natural geomorphic features appear to be responsible for much of the loss in the permitted areas. Therefore, any projects designed for marsh management should consider the ability of the project features to control relative water levels and minimize prolonged flooding.

The area included in #'s 1 and 84 have experienced relatively little historic loss and their is no indication that rates will increase significantly in the near future.

Permit #153 is partially contained in a project proposed by CWPPRA.

## CWPPRA

The restoration plan developed under the CWPPRA for the Teche/Vermilion Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Teche/Vermilion Basin closely approximates Hydrologic Unit 7 as defined by Chabreck, 1972. As summarized from CWPPRA, the primary causes of wetland loss in the Teche/Vermilion Basin are shoreline erosion and hydrologic changes that alter the balance between the marsh maintenance and deterioration processes. The key planning objectives for the Basin include:1)maximize the flooding of marshes with flowing, fresh, sediment-rich water; 2)slow, stop, or reverse marsh loss in hot spots; and 3)protect critical shorelines.

Figure ? shows the location of the proposed marsh management projects in Unit 7 from the CWPPRA Plan. A portion of TV-4 has been permitted. The areas covered by proposed projects TV-10, TV-1, TV-8, and TV-5/7(1) have experienced high rates of shoreline erosion during the past 60 years. Project #'s TV-10 and TV-5/7(1) also contain some man-made loss. All four of these project areas have experienced minimal interior loss. Any projects designed to retard shoreline erosion should benefit these areas, especially if the protection is able to keep the shoreline from intersecting interior lakes and ponds. The area covered by project TV-4 is characterized by high interior, shoreline, and man-made loss. Alterations to the hydrology, especially those which have increased tidal scour and impoundment, appear to be responsible for much of the interior loss in this area. The proposed project should be beneficial assuming that ponding of water in the interior marshes is avoided.

In addition to those projects classified as marsh management, CWPPRA has proposed other projects which address many of the areas of past and anticipated future loss listed previously.

The CWPPRA Plan estimates that 14,700 acres (6.1%) of loss will occur in the next 20 years without project implementation. Much of this loss will be in the form of shoreline erosion and conversion of interior marshes to shallow ponds.

## Summary

As discussed previously, during the 1983 to 1990 period a majority of Unit 7 was losing less than 0.5 percent of its land area each year. Only 4 quadrangles bordering Vermilion and West Cote Blanche Bays were losing more than 0.5 percent per year.

The overall rate of loss in Unit 7 should decrease slowly assuming the continued recent decline in direct man-made loss and the associated loss resulting from alterations to the hydrology. Also, the loss rate will decrease somewhat due to the continued beneficial effects of fresh water and sediment from the

Atchafalaya River. Shoreline erosion will continue to be a major cause of loss in this Unit.

## UNIT 8

### Location

Hydrologic Unit 8 encompasses the Mermentau Basin which includes the Mermentau River, Grand and White Lakes, and the associated marshes. It shares a common boundary with Unit 7 on its eastern side. The western boundary lies along a line beginning at the Gulf of Mexico approximately 5 miles west of Mermentau River. From there, the line runs north to Louisiana Highway 27. The boundary follows Highway 27 east and north to the Intracoastal Waterway, then west along the Intracoastal to the Calcasieu Locks (Fig. 1).

### Geologic Setting

Unit 8 is located in the central portion of the Chenier Plain. This unit is comprised predominantly of fresh and brackish marshes. Saline marshes exist only along the Gulf shoreline and intermediate marshes are found in a narrow band between the fresh and brackish marshes. Man-made features such as Highway 82, Freshwater Bayou, and numerous water control structures play an important role in the distribution of marsh types in Unit 8.

Stranded beach ridges (cheniers), beaches along the Gulf shoreline, and isolated Pleistocene outcrops scattered throughout the interior marshes comprise the only significant natural areas with ground elevations greater than marsh level. Typical geologic profiles in the area show that the subsurface is generally composed of a relatively thin Holocene sequence underlain by Pleistocene deposits. The Holocene is typically composed of soft to medium clay with thin organic zones overlain by approximately 2 feet of organic clay, peat, and marsh. Holocene sediments range from 0 to 30 feet in thickness except in the Mermentau River Entrenchment where thicknesses up to 60 feet are found. Holocene deposits are the result of a combination of riverine and longshore transport processes. The variability of these two processes is responsible for the alternating beach ridges separated by marsh characteristic of the chenier plain. The Pleistocene outcrops just north of the gulf Intracoastal Waterway (GIWW) in most of Unit 8 and just south of the GIWW at Pine and Outside Islands. From there the Pleistocene slopes southward to about -30 feet NGVD at the coast except in the Mermentau River Entrenchment where it varies with the depth of the entrenchment. Holocene sediments deposited approximately

3000 years before present can be found at -6 feet NGVD in the central portion of Unit 8 indicative of the relatively low subsidence rates in this Unit. Average long term relative subsidence rates in Unit 8 are approximately 0.23 ft/century.

Historic Land Loss

The average annual land loss rate increased steadily from 1932 to 1983 in Unit 8. During the 1932 to 1955 period the average rate was 1.55 sq mi/yr. The rate increased to 4.53 sq mi/yr during the 1955 to 1974 period, and peaked at 4.62 sq mi/yr during the 1974 to 1983 period. Since then the rate has decreased to 3.39 sq mi/yr for the 1983 to 1990 period. The average annual percentage of land being lost has followed the same pattern. During the 1932 to 1955 period Unit 8 lost an average of 0.15 percent of the available land area each year. The average yearly percentage increased to 0.46 during the 1955 to 1974 period, and to 0.52 percent for the 1974 to 1983 period. The percentage of land being lost each year decreased to 0.40 during the 1983 to 1990 period (Fig 15). By 1990, Unit 8 had lost approximately 19 percent of the land areas present in 1932. As shown in Figure 15, the majority of this loss occurred during the 1955 to 1983 period. Direct man-made loss accounted for approximately 7 percent of the total loss from 1932 to 1990. Figure 16 shows the average annual percentage of land loss for each of the 7.5 minute U.S. Geological Survey quadrangles approximating Unit 8 for the 1983 to 1990 period. This figure shows that the percentage of land being lost is variable throughout Unit 8. During the 1983 to 1990 period the area around White Lake experienced a high percentage of land loss with the area south of White Lake having a percentage loss rate of over 1 percent per year.

Location of Historic Loss

Areas which have experienced high rates of interior land loss in Unit 8 include:

1. north of the Intracoastal Waterway in and around the Laccasine National Wildlife Refuge
2. between Hwy 27 and Grand Lake
3. east of Grand Lake, between the Intracoastal Waterway and White Lake
4. between Hwy 82 on the north, Lower Mud Lake on the west, the Gulfshore on the south, and the eastern boundary of Unit 8
5. north of Sweet Lake

Some areas where shoreline erosion rates have been especially high include:

1. the Intracoastal Waterway
2. the Gulfshore from south of Lower Mud Lake to just east of Rollover Bayou
3. along the Mermentau River just above Grand Lake

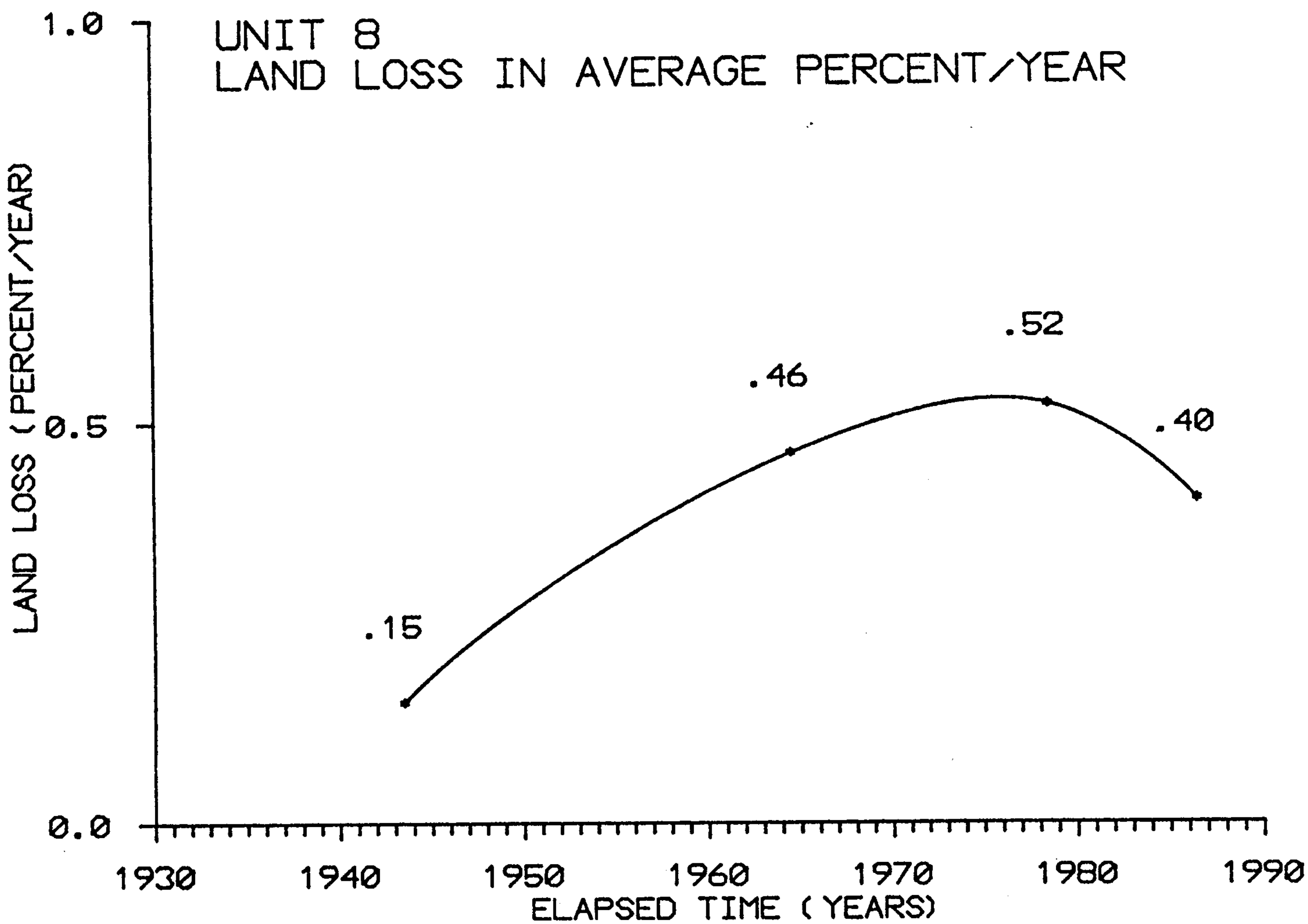

UNIT 8
LAND LOSS IN AVERAGE PERCENT/YEAR
1.0
0.5
0.0
LAND LOSS ( PERCENT/YEAR)
.15
.46
.52
.40
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)

Figure 15.

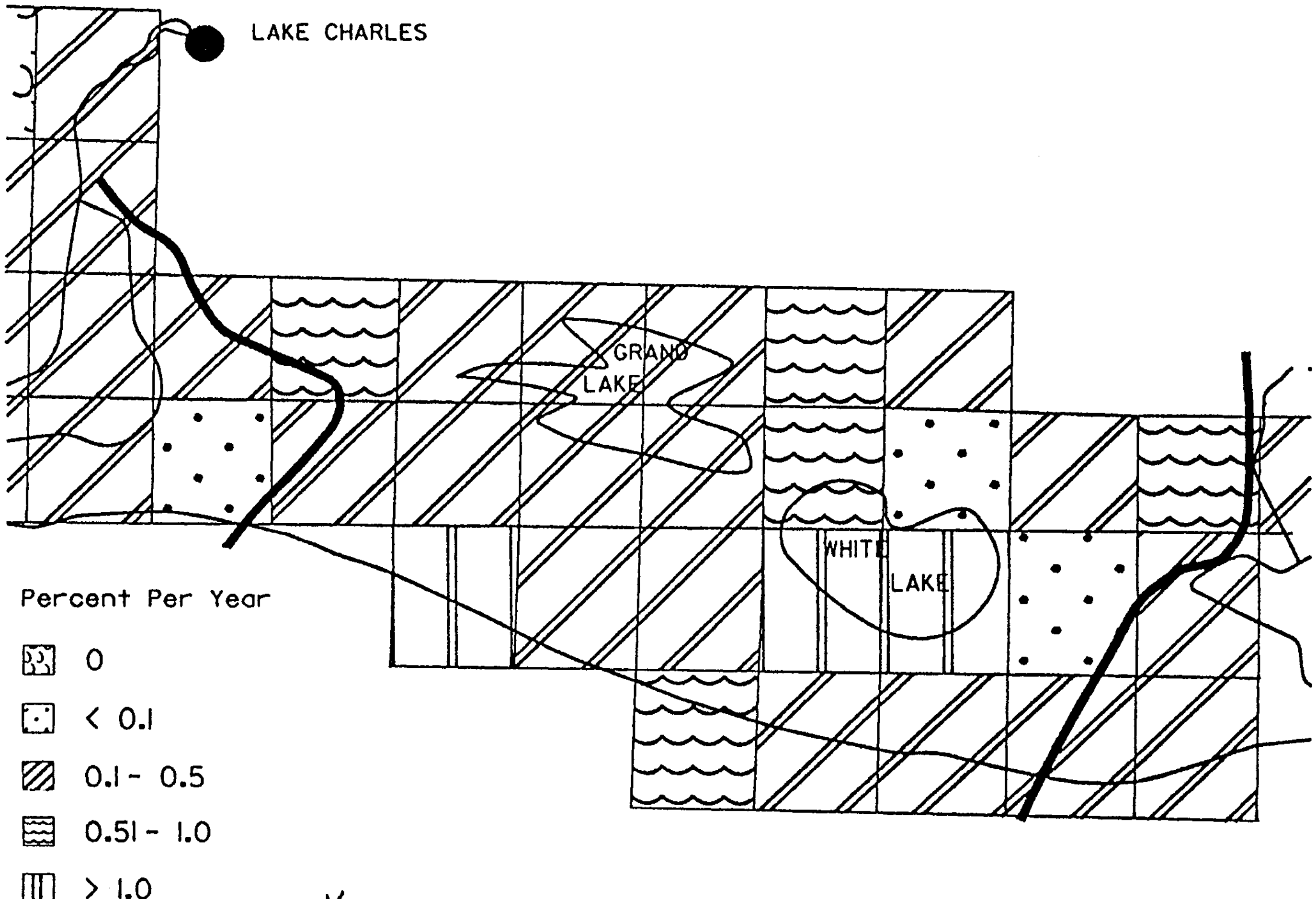



Figure 16. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

4. the shoreline of Grand Lake, especially Grassy, Tebo, Umbrella, and Short Points, and Rabbit and Bird Islands
5. the shoreline of White Lake, especially on the eastern and southern shores
6. the shores of Lake Misere, Willow Lake, Sweet Lake, and the numerous small lakes
between Grand and White Lakes

Some sites where direct man-made loss has been relatively high include:

1. south of Lake Misere
2. east of White Lake
3. southeast of Pecan Island
4. between Freshwater Bayou and Hwy 82

From the available data (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of historic land loss in Unit 8 appear to be shoreline erosion, alterations to the hydrology, and direct man-made loss.

Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased in Unit 8 since the 1974 to 1983 period. However, this decrease follows a long period of increasing rates (1932 to 1983) and therefore may only reflect a short term change. The main reason for the decrease in rates during the 1983 to 1990 period was a reduction in the rate of loss within the interior marshes.

Some areas where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline from south of Lower Mud Lake to just east of Rollover Bayou
2. the shoreline of Grand and White Lakes especially at the points where the shore protrudes into the lakes
3. the shorelines of smaller lakes such as Cullicon Lake, Lake Misere, Latina Lake and Sweet Lake
4. interior marshes north of White Lake and due south of Pecan Island
5. in the vicinity of Second Lake, south of Grand Chenier Ridge
6. east of Hwy 27 near the Intracoastal Waterway

In the areas identified in 4,5, and 6 above, alterations to the hydrology appear to be responsible for the loss.

Areas where land loss rates have been relatively low but may increase in the near future include:

1) Areas where the eroding lake and Gulf shorelines intersect isolated lakes in the interior marshes. This allows

waves and currents from the large lakes and Gulf to act directly on previously protected interior marshes. Catfish Lake located in the southwestern corner of Grand Lake and Clear Lake located in the northeastern corner of White Lake are examples of this situation related to lakes. Tolan Lake, Big Constance Lake, and Flat Lake are examples of lakes whose shorelines have been or may be intersected by the Gulf shore.

2) Areas where man's activities have led to alterations in the surface hydrology making them susceptible to marsh loss. Examples where this may occur include:

a. southeast of Pecan Island
b. due east of White Lake.
c. south of Lake Misere
d. between White Lake and Freshwater Bayou, south of the Intracoastal Waterway

The direct loss due to dredging activity in Unit 8 has decreased since 1974 and will probably continue to decrease.

Permits

Fifteen marsh management permits have been issued within Unit 8 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects. The areas covered by permit #'s 5, 260, 1, 2, 197, 220, 839, 252, 1014, and 906 have experienced relatively high rates of interior marsh loss. Permit #'s 260 and 220 also have had relatively high man-made loss. In the area covered by permit #1, most of the loss occurred prior to 1955. The area covered by permit #1014 is contained within the boundaries of #5. Moderate interior and man-made loss has occurred in the area of Permit #200. The interior loss in all of these permitted areas appears to be related to alterations to the hydrology; especially those which lead to impoundment, increased tidal exchange, or salt water intrusion or some combination of all three. Therefore, any projects planned for these areas should consider the ability to control relative water levels.

The areas included in permit #'s 7, 151, 710, and 770 have experienced minimal loss in the past 60 years.

CWPPRA

The restoration plan developed under the CWPPRA for the Mermentau Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Mermentau Basin follows the same boundaries as Unit 8. As summarized from CWPPRA, the primary causes of wetland loss in the Mermentau Basin are prolonged flooding, salt water intrusion, and tidal scour, all of which have resulted from alterations to the hydrology. Roads, levees, control structures,

navigation channels, and canals are examples of alterations which influence the hydrology in this Basin.

Strategies developed to preserve and restore wetlands in this basin include:1) reduce inundation in the Lakes Subbasin by managing water levels with existing structures; 2) reduce inundation in the Lakes Subbasin by developing additional outlets to the lakes; 3) reduce saltwater intrusion in the Chenier Subbasin by using water evacuated from the Lakes Subbasin; 4) utilize small scale measures to preserve or restore marsh in areas of critical need or opportunity; and 5) preserve the geologic framework of the Basin by shoreline and bank protection. Figure shows the location of the proposed marsh management projects in Unit 8 from the CWPPRA Plan.

The areas covered by proposed projects XME-46, PME-14, and ME-2 have experienced relatively high rates of interior marsh loss. PME-14 covers the same area as permit #1014 which was discussed previoysly. PME-15, XME-45, and XME-40 are characterized by relatively moderate rates of interior marsh loss. Most of the loss in XME-46, PME-15, and ME-2 occurred prior to 1974. Most of the loss in XME-45 has occurred since 1983. PME-15 has also experienced a moderate amount of man-made loss. In all of the permitted areas, alterations to the natural hydrology appear to be responsible for the observed losses. Measures to reduce flooding and tidal scour should benefit these areas.

The CWPPRA Plan estimates that 39,600 acres (8.6%) of the Basin's existing wetlands will be lost in the next 20 years without project implementation. Much of this loss will occur on the shorelines of Grand and White Lakes, the banks of the GIWW and Freshwater Bayou, The Gulf shoreline, and the interior marshes in the Deep Lake, Freshwater Bayou, and Little Pecan Bayou areas. Interior losses will also occur south of Pecan Island and Grand Chenier.

<u>Summary</u>

From the available information relative to land loss in Unit 8, it appears that alterations to the surface hydrology and shoreline erosion are the dominant processes influencing the land loss rate in this area.

As shown in Figure 16, during the 1983 to 1990 period the percentage of land being lost on individual 7.5 minute quadrangle units is highly variable. The percentage of land being lost ranges from less than 0.1 percent to over 1.0 percent per year. The majority of Unit 8 was losing land at a rate between 0.1 and 0.5 percent per year.

The overall rate of loss within Unit 8 should remain approximately the same or decrease slowly assuming the continued recent decline in man's activities (dredging of canals and construction of roads and levees) within the wetlands.

## Unit 9

### Location

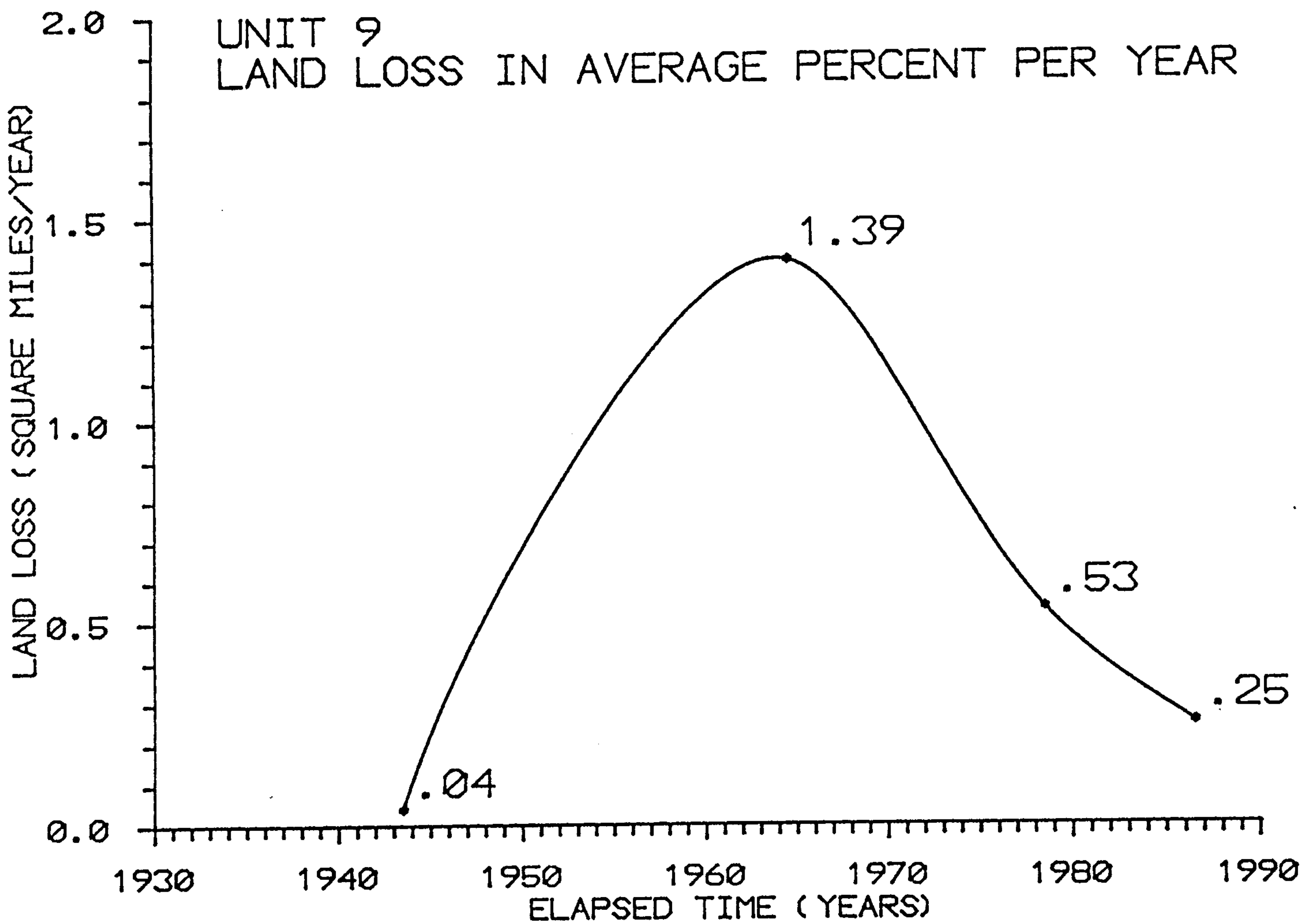
Hydrologic Unit 9 is located in the western half of Cameron Parish and includes the area drained by the Calcasieu and Sabine Rivers. It shares a common boundary with Unit 8 on its eastern side. Its western boundary follows the Louisiana State Line in the Sabine River and Lake (see Figure 1).

### Geologic Setting

Unit 9 is located in the extreme western portion of the Chenier Plain. This unit contains fresh, intermediate, brackish, and saline marshes. Man-made features such as navigation channels, access canals, levees, and roads play an important role in the distribution of marsh types in Unit 9. Hackberry Dome, stranded beach ridges (cheniers) and beaches along the Gulf shoreline comprise the only significant natural areas with ground elevations greater than marsh level. Typical geologic profiles in the area show that the subsurface is composed of a thin Holocene sequence underlain by Pleistocene deposits. The Holocene is typically composed of soft to medium clay with thin organic zones overlain by approximately 2 feet of peat, organic clay, and marsh. Holocene sediments generally range from 1 to 25 feet in thickness except in the Calcasieu River Entrenchment where thicknesses up to 70 feet are found. Holocene deposits are the result of a combination of riverine and longshore transport processes. The variability of these two processes is responsible for the alternating beach ridges separated by marsh characteristic of the chenier plain. Pleistocene deposits are generally very stiff, oxidized clay with low water contents and high compressive strengths. The Pleistocene surface represents the most stable surface in coastal Louisiana. Generally, where the depth to the Pleistocene is shallow (<50 ft) subsidence rates are relatively low. The Pleistocene outcrops near the Calcasieu Locks and south to Willow Lake and at the Hackberry Dome. From these sites the Pleistocene surface slopes gently southward to about -25 feet NGVD at the coast except in the Calcasieu River Entrenchment where it varies with the depth of the entrenchment. Holocene sediments deposited approximately 5000 years before present can be found at -14 feet NGVD on the south shore of Calcasieu Lake indicative of the low subsidence rates in this unit. Average long term relative subsidence rates in this Unit are approximately 0.23 ft/century.

### Historic Land Loss

The average annual land loss rate for the 1933 to 1955 period was 0.26 sq mi/yr. The rate increased dramatically to 7.98 sq mi/yr during the 1955 to 1974 period and then decreased almost as dramatically to 0.94 sq mi/yr during the 1983-1990 period. The



UNIT 9
LAND LOSS IN AVERAGE PERCENT PER YEAR
LAND LOSS ( SQUARE MILES/YEAR)
2.0
1.5
1.0
0.5
0.0
1.39
.53
.25
.04
1930
1940
1950
1960
1970
1980
1990
ELAPSED TIME ( YEARS)


Figure. 17

average annual percentage of land being lost has followed the same pattern (Fig. 17). The percentage of land lost reached a maximum of 1.39% per year during the 1955 to 1974 period and has since decreased to 0.25% per year for the 1983 to 1990 period. By 1990, Unit 9 had lost approximately 32% of the land area present in 1933. Only Unit 3, located at the mouth of the Mississippi River, has lost a greater percentage of its 1930's land area. Direct man-made loss accounted for approximately 2% of the total loss in Unit 9 during the 1933 to 1990 period. Like most of the hydrologic units in coastal Louisiana, most of the land loss occurred during the 1955 to 1974 period. Approximately 82 percent of the total loss in Unit 9 occurred during the 1955 to 1974 period. Figure 18 shows the average annual percentage of land lost for each of the 7.5 minute quadrangles approximating Unit 9 for the 1983 to 1990 period. This figure shows that the percentage of land lost during the 1983 to 1990 period generally falls between 0.1 and 0.5 percent per year.

Location of Historic Loss

Some areas which have experienced especially high rates of interior marsh loss in Unit 9 include:

1. south of Grand Lake Ridge between Calcasieu Lake and the Intracoastal Waterway
2. adjacent to Hwy 27 in the vicinity of Broussard and Boudreaux Lakes
3. south of Calcasieu Lake, north of Back Ridge
4. west of Calcasieu Lake in the vicinity of Browns and Black Lakes
5. west of Mud Lake adjacent to East Bayou
6. between Starks Central and Starks North Canals
7. west of Burton Sutton Canal, east of Sabine Lake

In these areas, surface landscape features (both nayural and man-made) appear to be highly correlative with interior land loss. These features alter the natural hydrology leading to high relative water levels, restricted surface flow, reduced sediment transport, saltwater intrusion, and tidal scour.

Some areas where shoreline erosion has been especially high include:

1. the Gulf shoreline, especially in the vicinity of the Calcasieu Ship Channel and Peveto Beach
2. the eastern shoreline of Calcasieu Lake
3. the banks of the Intracoastal Waterway

Some sites where direct man-made loss has been relatively high include:

1. east of Black Lake
2. near the intersection of Starks South Canal and Old North Bayou

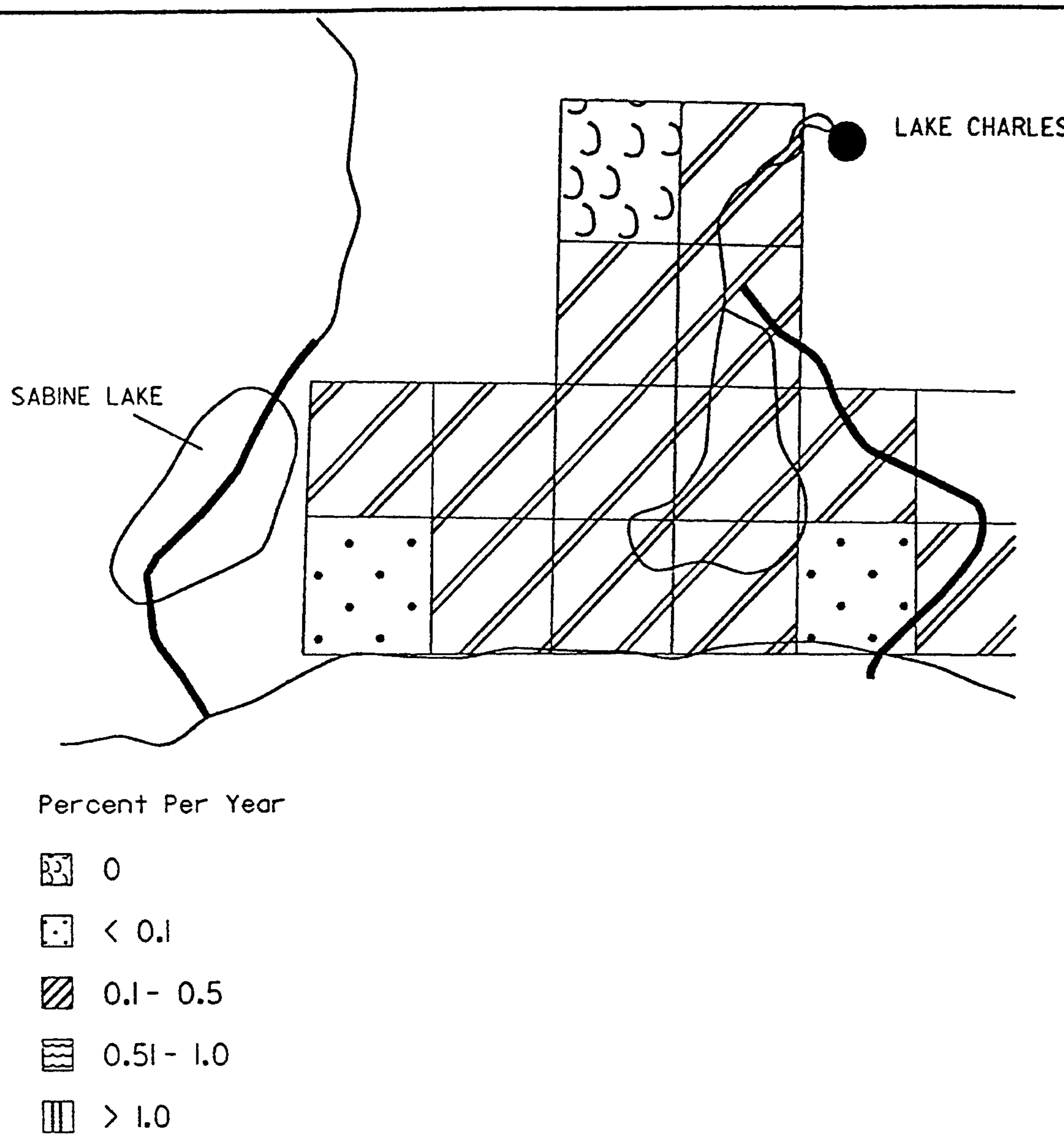



Figure 17. Average annual percentage of land loss for each of the 7.5 minute USGS quadrangles approximating the Unit for the 1983 to 1990 time period.

From the available data (i.e. engineering geology, geomorphic maps, marsh types, subsidence, and land loss) the primary causes of land loss in Unit 9 appear to be alterations to the hydrology and shoreline erosion.

## Future Areas of Loss

As shown previously, both the square miles and percentage of land being lost has decreased significantly in Unit 9 since the 1955 to 1974 period. The main reason for this decrease was the dramatic reduction in land loss within the interior marshes. This reduction may be due to several factors. First, the marsh areas most susceptible to changes in relative water levels (i.e. slightly lower ground elevations) and salinity changes were lost rapidly. Since then, land is still being lost, but at a slower rate. Second, many of these areas are intensively "managed" and as management techniques have improved, and problem areas addressed, the resulting loss has decreased. Third, during the 1955 to 1974 period several hurricanes and flooding events occurred that may have been responsible for much of the land loss which occurred during this period.
Some sites where land loss rates will probably remain relatively high or increase include:

1. the Gulf shoreline immediately west of the Calcasieu Ship Channel
2. the marshes in the vicinity of Boudreaux Lake
3. between the south shore of Calcasieu Lake and Back Ridge
4. west of West Cove on Calcasieu Lake
5. north of the Intracoastal Waterway, north of Black Lake
6. between Mud Lake and the Calcasieu Ship Channel
7. between Hamilton Lake and Starks South Canal

At sites 2 through 7, alterations to the hydrology appear to be responsible for most of the loss in these areas.

The physical erosion of marshes by wave and current action will likely increase as the size of open water areas in the interior marshes increases.

The direct loss due to dredging activity in Unit 9 has decreased since 1974 and will probably continue to decrease.

## Permits

Eleven marsh management permits have been issued within Unit 9 (see Figure ?). Waterfowl management and marsh restoration are the primary purposes stated for these projects.

The areas covered by permit #'s 382, 30, 7, 744, 863, 963, 832, 20051, and 923 have experienced relatively high rates of interior marsh loss. The loss in these areas appears to be related to alterations in the natural hydrology; especially those

which increase relative water levels, allow tidal scour, or lead to salt water intrusion. Therefore, the ability to control relative water levels should be considered as part of any project planned for these areas. In the areas covered by permit #'s 30, 744, and 832, it is possible that subsidence related to development around the Hackberry Dome may be responsible for some of the loss in these areas.

The areas included in permit #'s 67 and 611 have experienced little or no loss in the past 60 years.

## CWPPRA

The restoration plan developed by CWPPRA for the Calcasieu/Sabine Basin summarized the existing conditions, identified the problem areas, and proposed projects to address the problem areas. The Calcasieu/Sabine Basin follows the same boundaries as Unit 9. As summarized from CWPPRA, wetland loss within the basin is largely the result of extensive hydrologic alterations to the wetland building and maintenance functions; especially those which lead to salt water intrusion and tidal scour.

Strategies developed to preserve wetlands in this basin include: 1) preserve marshes by decreasing saltwater intrusion and detrimental water circulation patterns with locks in the major waterways; 2) preserve marshes by decreasing saltwater intrusion and detrimental water circulation patterns at the basin perimeter; and 3) maintain the geologic framework of the basin.

Figure shows the location of the proposed marsh management projects in Unit 9 from the CWPPRA Plan. The areas covered by proposed projects SO-3, SO-5, SO-6, SO-8, SA-1, SA-3, SA-4, SA-5, SA-6, SA-7, CS-10, CS-14, XCS-44, NO-1, NO-2, NO-2A, NO-3, NO-4, NO-5, NO-8, NO-14A, and PCS-25 have all experienced relatively high rates of land loss since the 1950's. Surface landscape features (roads, levees, canals, navigation channels, cheniers, and Pleistocene outcrops) appear to be highly correlative with this loss. Most of these projects involve some type of barrier designed to restrict free water exchange and reduce saltwater intrusion. One problem with these types of projects is the difficulty in maintaining favorable water levels within the managed areas. High relative water levels may lead to marsh loss or make restoration of marsh areas difficult.

The areas included in project #'s SO-4, SA-2, and SO-1 have experienced relatively low rates of land loss since the 1930's. However, these areas can be characterized as having altered hydrology just as those areas previously discussed and may experience the similiar problems in the near future.

The Corps GIS does not contain land loss data on project #'s NO-13, NO-14, NO-15, NO-17, NO-19, NO-20, NO-21, CS-5/A/12, XCS-48, PSC-10, SO-1A, and SO-2. Therefore these areas could not be characterized relative to historic loss. However, surface landscape features in these areas are similiar to those described

previously and the same processes are probably responsible for the losses in these areas.

The CWPPRA Plan estimates that 21,900 acres (approximately 9%) of the Basins existing wetlands will be lost in the next 20 years without implementation of proposed projects. The landscape will evolve into a system dominated by large water bodies of open, relatively turbid water. Physical erosion around the perimeters of these open water bodies will increase.

<u>Summary</u>

From the available information relative to land loss in Unit 9, it appears that alterations to the hydrology and shoreline erosion are the dominant processes influencing the land loss rate in this area.

As shown in Figure 18, during the 1983 to 1990 period most of Unit 9 lost between 0.1 and 0.5 percent of its available land area each year. Since much of the loss in Unit 9 appears to be related to man's activities (i.e. dredging of canals and building of roads and levees) it is difficult to predict the trend in future loss rates. However, assuming the continued recent decline in man's activities within the wetlands the overall rate of loss should continue to decrease slowly. The shorelines of all existing water bodies will continue to erode at varying rates depending on the materials being eroded and the frequency and magnitude of storm events (both winter and summer). If water levels are artificially high within the areas of altered hydrology shoreline erosion rates as well as overall loss rates will increase rapidly.

I - Avifauna

The standard reference for bird distribution in Louisiana is the somewhat dated Louisiana Birds (Lowery 1974). A revised version is in preparation by other authors. A useful reference for basic data on all coastal species is The Birder's Handbook (Erlich et al., 1988). Brief summaries of basic breeding data, nest site and description, diet, conservation, and pertinent references are listed. More useful is the in-progress species by species reports of The Birds of North America (1993 onward). Published as stand-alone summaries of each species' natural history, this partially completed work incorporates the latest findings on habitat, breeding phenology, demography and populations, conservation, management, and references.

A Louisiana Breeding Bird Atlas showing distribution of all breeding birds in the coastal zone is in the early stages of preparation. Hamel's 1992 The Land Manager's Guide to the Birds of the South briefly summarizes the key habitats, sample breeding densities, food habitats, and pertinent references for all breeding species of Louisiana coastal birds. Charts showing favored water types (fresh, brackish, salt, all) for all species is particularly valuable for marsh managers. Buckley and Buckley (1976) set down guidelines for the protection and management of colonially nesting waterbirds including herons and tern colonies. Recommendations for colonies in marshlands include control of aquatics and emergents by water level manipulation, eradication of aggressive monocultures like *Phragmites* unless known to be used by colonial waterbirds, and maintenance of water levels to provide proper depths for foraging and for preservation of important prey species of fishes and invertebrates. Additional guidelines include differential seasonal regulation of water levels for migrating shorebirds and waterfowl, preventing water from getting so high that it kills important trees or plant species or covers islands, and control of Ph, salinity, aquatic, and emergent plants to maximize their value to colonial birds and their prey species.

Specific species needs include 6-8 inches of water in coastal marshes for foraging white-faced ibis for southwestern Louisiana, preservation of thickets near a body of water for breeding areas for glossy ibis in southeastern Louisiana, marshes with tall herbaceous vegetation for least bitterns in fresh water marshes, elevated perches in trees or shrubs for nesting and roosting neotropical cormorants, shallow water feeding areas in salt or brackish marshes for roseate spoonbill foraging, and 6-10 inches deep shallow fresh water areas for feeding wood storks. Other key habitat requirements include open fresh water with marshy vegetation along the shores for common moorhens, freshwater marshes with floating and emergent vegetation for purple gallinules, thick herbaceous cover in semi-moist places and

at times in dry areas for wintering yellow rails, and dense herbaceous cover of marshes or wet meadows for black rails. Martin and Lester's 1990 work show the location of all known wading bird and seabird colonies in coastal Louisiana on US Geological Survey Quads and species composition of the colonies.
A regional study useful for waterbird data in the Marsh Island area was published by the U.S. Fish and Wildlife Service in 1983. Data on bird distribution, abundance, seasonal occurrence,
and habitat use were derived from aerial surveys. Information on reproduction, behavior, and potential impacts of Outer Continental Shelf development are also discussed. A 1985 work (Louisiana Universities Marine Consortium) looked at the long-term effects of off shore oil and gas development on wetlands including bird populations. Study results discussed effects of oil fouling on birds and the effects of noise and other physical disturbances on birds. The U.S. Fish and Wildlife Service has published a series of habitat suitability index models designed for a wide variety of planning applications where habitat information is an important consideration in the decision process. Relevant published bird models include: great egret, roseate spoonbill, white ibis, great blue heron, lesser snow goose (wintering), greater white-fronted goose, mallard (LMV-wintering), mottled duck, northern pintail (gulf coast wintering), blue-winged teal. lesser scaup (wintering), redhead (wintering), bald eagle, clapper rail, laughing gull, least tern, Forster's tern (breeding), belted kingfisher, and red-winged blackbird.

Clapp's 1982 Marine Birds of the Southeastern United States and Gulf of Mexico Part I Gaviiformes through Pelicanformes notes the preferred breeding and feeding habitat for a few Louisiana breeding waterbirds including pied-billed grebe and neotropical cormorant. He notes that the neotropical cormorant fed mostly on fish that characteristically prefer protected inshore waters to open lake waters. Chabreck (1963) looked at breeding pied-billed grebes on a Louisiana impoundment. He found that most nests (52%) were in open water, the rest (46%) in small stands of wiregrass (*Spartina patens*). Distance to the nearest stand of dense emergent vegetation averaged 60 meters with a range of 1-183 m.

Stutzenbaker (1988) found the most commonly used breeding habitat for coastal breeding mottled ducks was an association of smooth and rough cordgrass dominant over other grasses. Areas with the highest nest densities were the well-drained cordgrass ridges located immediately adjacent to the permanently wet marsh. The second most productive nesting area was the cattle-pasture and rice production zone, typified by a mixture of prairie grasses dominated by smutgrass, paspalum, and bluestem. Pastures with suitable nesting cover are widely interspersed across

the large inland prairie zone, and light to moderate nesting activity occurs wherever there is adjacent surface water. The most desirable water areas in the prairie sites are the natural shallow depressions called "sennabean ponds." These shallow, temporary prairie ponds hold water during wet periods and offer all necessities for breeding, brood rearing, and molting. Osborn (1983) specifically looked at mottled duck nesting and brood rearing habits in Cameron Parish.

Erskine's (1971) monograph on buffleheads identified favored wintering habitat in coastal areas as "shallow waters over mud flats exposed at low tide." Other favored habitats included broad, sandy bays, the upper end of which terminated in a shallow slough about 18 inches deep and the quiet, shallow (3-10 feet) water, over soft bottoms, of reaches, sheltered coves, and bays.
Paulus (1984) looked at activity budgets of non-breeding gadwalls in Louisiana marshes. Gadwalls rarely left foraging sites during day or night except when disturbed or during hunting season. Hunting in marshes around the Rockefeller Refuge forced many gadwalls to leave these marshes during the day and use impounded marshes on the refuge. His thesis (1980) looked at the wintering ecology of the gadwall in Louisiana. Swiderek (1982) investigated waterfowl usage of three specific plants including sea purslane, Gulf Coast muskgrass, and wigeongrass in brackish impoundments in coastal South Carolina and notes that sea purslane is managed in Louisiana. Sea purslane offers managers a viable alternative to wigeongrass and an opportunity to increase diversity of food and waterfowl species.

The <u>Waterfowl Management Handbook</u> (Cross, 1988) offers species-specific summaries of breeding/wintering habitat for a variety of ducks and geese that winter in Louisiana. In <u>Marine Birds of the Southeastern United States and Gulf of Mexico, Part II, Anseriformes</u>,
Clapp et al. describe wintering habitats for 41 waterfowl species which occur in southern Louisiana and include a useful bibliography. Lokemoen and Messmer (1994) discuss the placement, management, and permitting of earthen and rock nesting islands in wetlands for waterfowl, colonial birds, and shorebird breeding sites. Junkin (1989) noted effects of various water regimes upon waterfowl food plants. Carloss (1988) looked at the diversity and relative abundant of avian species on Marsh Island, Louisiana. Abernethy (1986) researched the specific restoration practice of backfilling old pipeline canals and its effect upon both environmental conditions and waterfowl usage. The quantity and quality of waterfowl habitat in Louisiana was addressed by Williams and Chabrack (1986). Bettinger's thesis (1984) focused on the relative abundance of avian species by habitat on the Rockefeller Wildlife Refuge. Nassar (et al.,

1988) noted that brown seed millet rather than rice was the best forage for wintering waterfowl in rice fields but that rice attracted substantial numbers too and would obviously be favored by farmers. Heavy night use of rice fields by large flocks of wood ducks was an interesting sidebar to this study.

Dugoni (1975) looked at breeding habitats of bald eagles in forested wetlands just north of the coastal marshes in Louisiana. He found that eagles do not prefer certain nesting territories based on surrounding habitat availability alone. Dominant prey items included freshwater catfish and American coots indicated the importance of an abundance of wintering waterfowl and shallow lakes within the coastal zone.

Helmers (1992) notes that migrant and wintering shorebirds in the coastal areas exploit hypersaline lagoons, freshwater marshes, coastal beaches, deltas, shallowly flooded agricultural fields, and hypersaline tidal flats. Microhabitat requirements range from unvegetated mudflats to moderately vegetated open shallows ( 15 cm). Managing shorebirds in the Gulf region should focus on protecting natural habitats used by migrating and breeding shorebirds, reducing disturbance, and enhancing habitats in managed wetlands. Timed drawdowns to expose flats or shallows during peak migration periods has been utilized on several state and federal refuges in the region, generally from mid-April to 1 June and from 10 July through October.

White and James (1978) note requirements of wintering coots in coastal southeastern Texas adjacent to Cameron Parish, Louisiana. On average, coots fed in areas that were 90 cm deep with 20% cover of emergent vegetation and 40% cover of floating plus submerged vegetation. Hydrilla (*Hydrilla verticillata*) was noted as an important component of wintering habitat in both Florida (Hardin et al., 1984) and Texas (Esler 1990). Tacha and Braun (1994) delineate coastal habitat needs of wintering and breeding gallinules and rails. Purple gallinules breed primarily in fresh to intermediate salinity ( 5 ppt. salt content) marshes. Deep water marshes (0.25-1 m depth), lakes, and impoundments (primarily coastal, but also inland), with stable water levels and dense stands of floating, emergent and submergent vegetation provide excellent habitat for nesting gallinules. An additional study on nesting gallinules, their home range, and habitat selection in freshwater areas is Matthews (1983) thesis. Optimal habitat for clapper rails is low tidal salt marsh (low being defined as sites flooded at least once daily during high tide) dominated by cordgrass of moderate height and salinity levels exceeding 7,100 ppm at low tide and 5,600 ppm at high tide (Meanley 1985). Sharpe (1976) found Louisiana clapper rails were most abundant in dense smooth cordgrass.

Meanley (1969) found that the marshes of the deltaic and Chenier plains of the Gulf coast are the most important coastal wetlands for king rails. On intensively managed refuges, a complex of wetland units should include marsh habitats that naturally dry during the summer and may include extensive perennial vegetation (Reid 1993). Helm (1982) made a thorough study of nesting chronology of both common moorhens and purple gallinules in southwestern Louisiana.

Marine Birds of the Southeastern United States and Gulf of Mexico, Part III, Charadriiformes, delineates preferred breeding and wintering habitat for 22 species of gulls, terns, and skimmers found in southern Louisiana (Clapp et al., 1983). A bibliography is included. Soots, Jr. and Landin 1978) discuss the development and management of avian habitat on dredged material islands. There is a brief discussion of wetland plants and plant succession on these islands and a bibliography with several references to dredged material placement in wetlands.

A growing body of literature addresses the issues of trans-Gulf passerine migration, the decline in wintering/migratory habitat, and habitat fragmentation. Finch's 1990 report summarizes recent literature on population trends of neotropical migrants and the factors affecting migrant populations on the breeding and wintering grounds. Willow and other tree stands in Louisiana's southern marshes are often the first/last foraging grounds for trans-Gulf migrants. Research on bird usage of these habitats is currently underway at Sabine National Wildlife Refuge and other sites, but results as yet are unpublished. Sidney Gauthreaux (in press) has researched compared radar imagery from the 1980's with 1960's data and has found significant declines, particularly in early migration species (March 15-21), several of which utilize marsh-edge habitats.

The Handbook for Nongame Bird Management and Monitoring in the Southeast Region (1990) discusses habitat requirements, monitoring techniques, and conservation issues associated with 14 southeastern nongame species. Species accounts applicable to this paper include least and American bitterns, reddish egret, black rail, gull-billed tern, barn owl, bewick's wren, and seaside sparrow. The summary of major wetland legislative documents and their relation to wetland birds is highly useful. The publication notes the total lack of information on habitat requirements for the two bittern species, but does recommend experimenting with fires to create greater diversity of emergent species. Moist soil management, which includes a shallow perimeter where saltgrasses, rushes, or sedges can grow and careful attention to flooding schedules, provides important habitat for the black rail, probable resident of coastal Louisiana. Population declines in seaside sparrows may be due to subtle

ecosystem changes unknown at present.

## Bibliography

Abernethy, Robert K. 1986. Environmental Conditions and Waterfowl Use of a Backfilled Pipeline Canal. Thesis, Louisiana State University, Baton Rouge. 125pp.

Bettinger, Kim M. 1984. Relative Abundance of Avian Species by Habitat Type on Rockefeller Wildlife Refuge. Thesis, Louisiana State University, Baton Rouge.

Buckely, P.A. and F.G. Buckley. 1976. Guidelines for Protection and Management of Colonially Nesting Waterbirds. National Park Service. 51pp.

Carloss, Michael R. 1988. Diversity and Relative Abundance of Avian Species on Marsh Island Wildlife Refuge, Louisiana. Thesis, University of Southwest Louisiana, Lafayette. 181pp.

Chabreck, R.H. 1963. Breeding Habits of the Pied-billed Grebe in an Impounded Coastal Marsh in Louisiana. Auk 80: 447-452.

Clapp, Roger B. 1982. Marine Birds of the Southeastern United States and Gulf of Mexico, Part I, Gaviiformes through Pelicaniformes, Minerals Management Service, Bureau of Land Management, U.S. Fish and Wildlife Service, Washington, D.C. 637pp.

1982b. Marine Birds of the Southeastern United States and Gulf of Mexico, Part II, Anseriformes, Minerals Management Service, U.S. Fish and Wildlife Service, Washington, D.C. 504pp.

1983. Marine Birds of the Southeastern United States and Gulf of Mexico, Parts III, Charadriformes, Minerals Management Service, U.S. Fish and Wildlife Service, Washington, D.C. 853pp.

Cross, Diana H. 1993. Waterfowl Management Handbook. U.S. Fish and Wildlife Service, Fish and Wildlife Leaflet 13, Washington, D.C.

Dugoni, Joseph A. 1975. Habitat Utilization, Food Habits, and Productivity of Nesting Southern Bald Eagles in Louisiana. thesis, Louisiana State University, Baton Rouge, 151pp.

Erlich, Paul R., David S. Dobkin, and Darryl Wheye. 1988. The Birder's Handbook. Simon and Shuster, New York, 785pp.

Erskine, Anthony J. 1971. Buffleheads. Canadian Wildlife Service, Ottawa, Canada. 241pp.

Esler, D. 1990. Avian community responses to hydrilla invasion, Wilson Bulletin 102: 427-440.

Finch, Deborah M. 1991. Population Ecology, Habitat Requirements, and Conservation of Neotropical Migratory Birds. Rocky Mountain Forest and Range Experiment Station, USDA, 26pp.

Hamel, Paul B. 1992. The Land Manager's Guide to the Birds of the South. The Nature Conservancy, Chapel Hill, North Carolina, 367pp. and appendices.

Hardin, S., R. Land, M. Spelman, and G. Morse. 1984. Food Items of Grass Carp, American Coots, and Ring-necked Ducks from a central Florida Lake, Proc. Southeast Assoc. Fish and Wildlife Agencies 38: 313-318.

Helm, Robert Newton. 1982. Chronological nesting Study of Common and Purple Gallinules in the Marshlands and Rice Fields of Southwest Louisiana. Thesis. Louisiana State University, Baton Rouge, 114pp.

Helmers, Douglas L. 1992. Shorebird Management Manual. North American Waterfowl Management Plan, 58pp.

Hunter, William C. 1990. Handbook for Nongame Bird Management and Monitoring in the Southeast Region. U.S. Fish and Wildlife Service, Southeast Region, 198pp.

Junkin, George M. 1989. Effects of Water Management on Selected Biotic Communities in a Floating Freshwater Marsh. Thesis. Louisiana State University, 60pp.

Lokemoen, John T. and Terry A. Messmer. 1993. Locating, Constructing, and Managing Islands for Nesting Waterfowl. 1994. 19pp.

Louisiana Universities Marine Consortium. 1985. Long-term Effects of Offshore Oil and Gas Development: An Assessment and a Research Strategy. Final rept. 1985, 743pp.

Lowery, George A. 1974. Louisiana Birds, Louisiana State University, Baton Rouge.

Martin, Richard P. and Gary D. Lester. 1990. Atlas and Census of Wading Bird and Seabird Nesting Colonies in Louisiana 1990, Louisiana Department of Wildlife and Fisheries, Baton Rouge, 182pp.

Matthew, Jr., William Cannon. 1983. Home Range, Movements, and Habitat Selection of Nesting Gallinules in a Louisiana Freshwater Marsh. Thesis, Louisiana State University, Baton Rouge, 134pp.

Meanley, Brooks. 1969. Natural History of the King Rail. North American Fauna #67., U.S. Fish and Wildlife Service, 108pp.

1985. The Marsh Hen: A Natural History of the Clapper Rail of the Atlantic Coast Salt Marsh, Tidewater Publishing, Centreville, Maryland, 123pp.

Nassar, James R., Robert H. Chabreck, and David C. Hayden. 1988. Experimental Plantings for Management of Crayfish and Waterfowl, in Waterfowl in Winter, edited by Milton W. Weller, University of Minnesota Press, Minneapolis, pp.427-439.

Osborn III, Earl Baker. 1983. Nesting and Brood Rearing Habits of the Mottled Duck in the Coastal Marsh of Cameron Parish, Louisiana. Thesis. Louisiana State University, Louisiana, 71pp.

Paulus, Stuart Lindsey. 1980. The Winter Ecology of the Gadwall in Louisiana. Thesis. University of North Dakota, 357pp.

1984. Activity budgets of non-breeding gadwalls in Louisiana. Journal of Wildlife Management 48:371-380.

Poole, A., P. Stettenheim, and F. Gill, Eds. 1993. The Birds of North America, various titles by species name, The Academy of Natural Sciences, Philadelphia.

Reid, F.A. 1993. Managing Wetlands for Waterbirds. Trans. North Am. Wildlife and Nat. Resour. Conf. 58: 345-350.

Sharpe, T. L. 1976. Productivity and Distribution of the Clapper Rail in a Louisiana Salt Marsh, Thesis, Louisiana State University, Baton Rouge, 91pp.

Stutzenbaker, Charles D. 1988. The Mottled Duck, Its Life History, Ecology and Management. Texas Parks and Wildlife Department, Austin, 210p.

Soots, Jr., Robert F. and Mary Landin. 1978. Development and Management of Avian Habitat on Dredged Material Islands, U.S. Army Engineers Waterway Experiment Station, Vicksburg, Mississippi, 134pp.

Swiderek, Peter Karl. 1982. Production, Management, and Waterfowl use of Sea Purslane, Gulf Coast Muskgrass, and Wigeongrass in Brackish Impoundments. Thesis. University of Georgia, Athens, 105pp.

Tacha, Thomas C. and Clait E. Braun. 1994. Migratory Shore and Upland Game Bird Management in North America. Allen Press, Lawrence, Kansas, 223p.

U.S. Fish and Wildlife Service. 1983. Turtles, Birds, and Mammals in the Northern Gulf of Mexico and Nearby Atlantic Waters: An Overview Based on Aerial Surveys of OCS (Outer Continental Shelf) Areas with Emphasis on Oil and Gas Effects. Albuquerque, New Mexico, 482pp.

U.S. Fish and Wildlife Service. Date varies. Habitat Suitability Index Models, various titles, National Coastal Ecosystems Team, Slidell, Louisiana.

White, D.H. and D. James. 1978. Differential use of fresh water environments by wintering waterfowl of coastal Texas, Wilson Bulletin 90:99-111.

Williams, Sartor O. and Robert H. Chabrack. 1986. Quantity and Quality of Waterfowl Habitat in Louisiana. Research Report, School of Forestry, Wildlife and Fisheries, no.8. Louisiana Agricultural Experiment Station, Baton Rouge, 84pp.

J - Socioeconomic Appendix

## Marsh Management Socioeconomic Appendix

### 1. INTRODUCTION

1.1. This appendix has been developed for use as a template, outlining the socioeconomic parameters and relationships required in evaluating Corps projects, and briefly describing their potential significance with respect to future marsh management projects, including those permitted and regulated by the Corps. It provides an inventory of resource areas representing existing conditions and identifies issues and relationships which future permit applicants may be required to address. The appendix outlines factors which a permit applicant should measure and analyze in anticipation of potential impacts and public concerns relating to future marsh management projects. This report considers cumulative effects only to the degree that it identifies general guidelines for evaluating the social and economic effects of all projects, and to the degree that decisions regarding one project might bear on others. The existing conditions include not only conditions within the limits of the specific project sites but also socioeconomic conditions influencing or influenced by the development of projects.

1.2. The primary functions of marsh management projects are to modify salinity levels, sediment loads, flow velocity, and water levels, and to regulate tidal flows. The purposes and needs of marsh management projects permitted by the Corps of Engineers since the late 1970's have been defined as plans to maintain and/or enhance fish and wildlife resources, to develop additional fish and wildlife research, to restore the quality of the marshes, or to develop some combination of these activities. The purposes of marsh restoration projects are to reduce rates in subsidence, erosion, and land loss impacting socioeconomic conditions further inland. A small number of marsh management permits have also been issued as single-purpose aquaculture projects (marine fish and shellfish farming) but will not be addressed in this report. General regulations for evaluating the socioeconomic implications of such broadly defined purposes have been developed in response to the National Environmental Policy Act of 1969 (NEPA); the River and Harbor and Flood Control Act of 1970 (Section 122); the Federal Water Pollution Control Act of 1972 as amended (Clean Water Act); and a wide range of Congressional legislation, Executive Orders, and other agency regulations, requiring coordination with NEPA guidelines.

1.3. As discussed in other sections of this DEIS, several of the marsh management permits initially authorized have subsequently expired either because no action was ever taken on them or because they were only partially completed by the applicants. A number of marsh management projects considered in the DEIS have not yet been

approved under the Corps regulatory program, but have been identified as needed in the review process required by the Coastal Wetlands Protection, Planning, and Restoration Act (CWPPRA). Other CWPPRA plans have Federal sponsors and have already been completed; others may have Federal sponsors but have not yet been constructed; and still other projects considered part of the future without-project conditions are at different stages of the planning process and will require authorization from the Louisiana Wetlands Conservation and Restoration Task Force which is managing the functions of the CWPPRA. Table 1.3. (beginning on the following page) summarizes currently authorized projects and future projects to which Federal interests have been committed.

1.4. The columns in the table identify the general location of each project and drainage basin; whether the project has been a public or private investment; the date of permit issuance; the acreage initially authorized; symbols indicating the structural design of projects; and symbols identifying the project purpose or purposes (see symbols at the end of the table). The acreage figures shown for existing projects are those for the authorized project, unless otherwise indicated and footnoted. Note that in some cases, no work (nw) was done before the permit expired (E). In other cases a project has been partially (p) completed before the permit expired. The Sub-totals reflect the acreage of existing projects as modified, plus the acreage of projects pending. The figures for Totals indicate the Sub-totals plus the estimated acreage of CWPPRA projects considered part of the future without project. Note that the figures for several of these projects are not yet known and are so indicated (-?).

1.5. Section 2 identifies the general locations of existing and planned marsh management and hydrologic restoration projects within drainage basins along coastal Louisiana. Permit applications indicate that there is either a private or public demand for the project. The regulatory permit review process has been established for consideration of both the private and the public need of a marsh management project.

1.6. Section 3 outlines specific socioeconomic factors which may be significant in evaluating existing conditions, and possible future without-project conditions that could influence, or could be influenced by, the demand for water resource developments. The permit requirement paragraphs indicate the type of information which may be needed in evaluating future projects requiring regulatory permits. The identification of adverse impacts will form the basis of any subsequent mitigation plan. All of the issues listed may not be pertinent in evaluating any single permit application, since each project tends to have unique socioeconomic as well as physical characteristics. Conversely, applicants may need to consider additional issues which public concerns have identified, but were not included in the list. Certain issues may be more relevant at one location than at another. For example, the socioeconomic implications of a large marsh management project near an urban center where subsidence has been occurring at

comparatively rapid rates may be greater than the socioeconomic implications of a smaller project located in a relatively remote area where subsidence is occurring much more gradually. All other conditions being equal, the need for the first project may be significantly greater than the second project, in view of a greater potential for future damages and loss of life from spring floods and periodic hurricanes which pass through the coastal region.

TABLE 1.3.

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

NOTE: Explanations of the symbols and abbreviations are located immediately following the table.

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| PONTCHARTRAIN: | | | | | |
| St. Bernard Par. W/L 33 | Parish Govt. | 1983 | 3,080 | FG/VC | WF,MR |
| Lake Borgne Canal 5 | " | 1983 | 2,762 | FG | WF,MR |
| Lake Borgne Canal 6 | " | 1984 | 4,200 | " | " " |
| St. Bernard Par. W/L 69 | * | 1987 | 834 | VC | WF |
| St. Charles Par. W/L 156A | * | 1988 | 12,640 | VC/FG/ FC | WF |
| IWW-NO to Mobile 65 | * | 1993 | 13,974 | - | WF |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) Sub-total: | - | - | 37,490<br>37,490<br>N/A<br>N/A<br>37,490 | - | - |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| PONTCHARTRAIN: | | | | | |
| CWPPRA Plans: | | | | | |
| PO-6 | SCS | - | (5,924) | FC,VC/ FG/C | MR |
| PO-9a | - | - | (18,000) | | MR |
| PO-11 | - | - | (3,915) | | MR |
| PO-15 | - | - | (15,578) | | MR |
| XPO-84 | - | - | (2,089) | | -? |
| 1) Authorized:<br>2) Modified:<br>3) Pending:<br>4) CWPPRA Plan:<br>5) Totals: | - | - | 37,490<br>N/A<br>N/A<br>(45,506)<br>(82,996) | - | - |
| | | | | | |
| BRETON SOUND: | | | | | |
| St. Bernard Par. W/L 48 | Parish Govt. | 1983 | 3,080 p,E | FG/VC | WF/MR |
| Caernarvon Canal 1 | " | 1983 | 2,960 p,E | FG | " " |
| Bayou Mandeville 2 | " | 1983 | 5,272 p,E | FG | " " |
| Plaquemines Par. W/L 282 | * | 1985 | 2,260 p,E | FG/VC | WF,MR |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) CWPPRA Plan:<br>6) Totals: | - | - | 13,572<br>13,572<br>13,492<br>N/A<br>N/A<br>13,492 | - | - |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| BARATARIA: | | | | | |
| Barataria By WW 226 | * | 1981 | 1,190 | FG | WF,MR |
| Lafourche Par. W/L 480 | * | 1983 | 2,950 | VC | MR |
| " " 547 | * | 1984 | 3,573 p,E | FG/VC/LE | WF,MR |
| " " 517 | * | 1984 | 12,300 | FG/VC | WF,MR |
| " " 540 | * | 1984 | 45,657 | VC | WF |
| " " 529 | * | 1985 | 6,666 p,E | FG | WF,MR |
| " " 577 | * | 1985 | 8,700 p,E | VC/FC | WF,MR |
| Bayou Des Allemands 110 | * | 1985 | 5,976 | LE | MR |
| Bayou Des Allemands 107 | * | 1986 | 678 | FG | RE |
| Jefferson Par. W/L 192 | * | 1989 | 450 | FG/VC | WF,MR |
| " " 215 | Jean Lafitte Park | 1990 | 12,400 | FG/VC | WF,MR |
| Lafourche Par. W/L 733 | * | 1991 | 3,250 (5,385**) | PL | WF |
| Jefferson Par. W/L 229 | USFWS | 1991 | 140 | FC | RE |
| Lafourche Par. W/L 743 | Parish Govt. | 1991 | 123,000 | FG/FC/PL | MR |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects
Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| BARATARIA: | | | | | |
| Lafourche Par. W/L 718 | * | 1994 | 6,250 | – | – |
| Jefferson Par. W/L 260 | USDA-SCS | Pend -ing | (7,199) | – | – |
| 1) Applied for:<br>2) Authorized:<br>3) Modified to:<br>4) Pending:<br>5) Sub-total: | –<br><br>(See **) | – | 240,379<br>233,180<br>235,315<br>(7,199)<br>(242,514) | – | – |
| CWPPRA Plans: | | | | | |
| XBA-54 | none | – | (38,887) | – | – |
| PBA-32 | none | – | -? | – | – |
| BA-2 | SCS | – | (60,000) | – | – |
| BA-6 | SCS | – | (40,000) | – | – |
| BA-14 | none | – | ( 2,998) | – | – |
| PBA-34 | none | – | (15,600)<br>-? | – | – |
| PBA-35 | ? | – | ( 7,199) | – | – |
| PBA-61 | none | – | (3,994) | – | – |
| 1) Authorized:<br>2) Modified:<br>3) Pending:<br>4) CWPPRA Plan:<br>5) Totals: | –<br>(See **) | – | 233,180<br>235,315<br>(7,199)<br>(168,678)<br>(411,192) | – | – |
| | | | | | |
| TERREBONNE: | | | | | |
| Terrebonne Par. W/L 478 | * | 1982 | 456 | VC/LE | MR, WF |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| TERREBONNE: | | | | | |
| Terrebonne Par. W/L 496 | * | 1982 | [325] nw,E | VC/LE | WF,MA |
| " " 628 | * | 1983 | 3,350 p,E | FC | MR,WF |
| " " 625 | * | 1984 | 5,282 | C,LE,PL | MR |
| " " 696 | * | 1984 | 7,222 | FG/VC | MR,WF |
| St. Mary Par. W/L 146 | * | 1985 | 800 | FG,VC | WF,MR |
| St. Louis Canal 7 | * | 1987 | [45] nw,E | FG | MA,WF |
| Lafourche Par. W/L 637 | * | 1987 | [2,416] nw,E | - | WF |
| Terrebonne Par. W/L 822 | * | 1988 | [1,152] nw,E | FC/VC/ FG | MR,WF |
| Falgout Canal 2 | Parish Govt. | 1989 | 8,000 | FG/VC | MR |
| Terrebonne Par. W/L 870 | * | 1989 | 2,555 p,E | - | MR,FW |
| Lafourche Par.W/L 703 | * | 1990 | 644 | FG/FC | WF |
| Terrebonne Par. W/L 930 | * | 1990 | [1,900] nw,E | FG/VC /PL | WF,MR |
| Bayou LaLoutre 83 | US FWS | 1991 | 340 | FG/VC/ PL/LE | RE |
| Terrebonne Par. W/L 943 | * | 1991 | 4,100 | FG/VC /PL | WF,MR |
| " " 953 | * | 1991 | 3,000 | PL/FW | MR |
| " " 991 | * | 1994 | 4,374 | - | MR |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| TERREBONNE: | | | | | |
| Grand Bayou 169 | * | 1994 | 900 | – | WF |
| Lafourche Par. W/L 675a | * | 1995 | 950 | – | WF,MR |
| Terrebonne Par. W/L 1043 | NMFS | pend -ing | (4,200) | – | MR |
| " " 1044 | NMFS | pend -ing | (804) | – | MR |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) Sub-total: | – | – | 52,815<br>47,811<br>41,973<br>(5,004)<br>46,977 | – | – |
| CWPPRA Plans: | | | | | |
| PTE-26 | none | – | -? | – | – |
| PTE-26b | SCS | – | -? | – | – |
| PTE-23/XTE-33 | SCS | – | (9,964) | – | – |
| XTE-28 | none | – | -? | – | – |
| TE-6 | none | – | (5,407) | – | – |
| TE-7 | none | – | -? | – | – |
| TE-7a | – | – | (5,000) | – | – |
| TE-7b | – | – | (3,000) | – | – |
| TE-7c | – | – | (1,600) | – | – |
| TE-7d | – | – | -? | – | – |
| TE-8 | – | – | (7,008) | – | – |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects
Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| TERREBONNE: | | | | | |
| CWPPRA Plans: | | | | | |
| TE-19 | NMFS | – | (4,558) | – | – |
| XTE-56 | none | – | (2,248) | – | – |
| XTE-57 | none | – | (6,090) | – | – |
| TE-10/XTE-49 | none | – | -? | – | – |
| XTE-47/<br>XTE- 48 | none | – | (8,856) | – | – |
| TE-9 | none | – | (750) | – | – |
| XTE-58 | none | – | (18,206) | – | – |
| PTE-25 | none | – | (18,350) | – | – |
| TE-5 | none | – | (35,857) | – | – |
| XTE-60 | none | – | (11,080) | – | – |
| XTE-29 | none | – | (3,858) | – | – |
| XTE-55 | none | – | (12,266) | – | – |
| XTE-59 | none | – | (4,555) | – | – |
| PTE-22/24 | SCS | – | (5,230) | – | – |
| 1) Authorized:<br>2) Modified:<br>3) Pending:<br>4) CWPPRA Plan:<br>5) Total: | – | – | 47,811<br>41,973<br>(5,004)<br>(163,883)<br>(210,860) | – | – |
| | | | | | |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| TECHE/ VERMILION: | | | | | |
| Vermilion Par. W/L 138 | * | 1981 | 1,200 | FG,VC, LE | MR,WF |
| " " 151 | School Board | 1983 | 640 | FG,C | WF |
| LTAV 181-A | * | 1983 | 750 p,E | FC,PL | MR |
| Iberia Par. W/L 84 | * | 1983 | 4,500 | FC | WF |
| St. Mary Par. W/L 115 | * | 1983 | [133] nw,E | FG,LE,C | MR |
| Freshwater Bayou 27 | * | 1986 | 3,900 E | FG,VC | WF,MR |
| Vermilion Par. W/L 221 | * | 1986 | 690 p,E | FG,VC, LE | MR,WF |
| St. Mary Par. W/L 153 | * | 1986 | 3,085 p,E | FC,PL | MR,WF |
| Vermilion Par. W/L 239 | * | 1986 | 1,765 p,E | FG,VC, PL | MR,WF |
| " " 236 | * | 1987 | 1,035 | FG,VC | MR,WF |
| Bayou Cassmer 1 | * | 1989 | 1,100 c,E | SW | MR |
| Vermilion Par. W/L 272 | * | 1992 | 6,570 p,E | FG,VC | MR,WF |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) Sub-total: | - | - | 25,368<br>25,368<br>25,235<br>N/A<br>25,235 | - | - |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| TECH/ VERMILION: | | | | | |
| CWPPRA Plans: | | | | | |
| TV-1 | SCS | – | (2,181) | – | – |
| TV-4 | SCS | – | (30,000) | – | – |
| TV-5/7A | none | – | (6,697) | – | – |
| TV-8 | none | – | (400) | – | – |
| TV-10 | none | – | (2,683) | – | – |
| 1) Authorized:<br>2) Modified:<br>3) Pending:<br>4) CWPPRA Plan:<br>5) Totals: | – | – | 25,368<br>25,235<br>N/A<br>(41,961)<br>(67,196) | – | – |
| | | | | | |
| MERMENTAU: | | | | | |
| Little Pecan Bayou | * | 1977 | 5,000 | FG | WF |
| LTVM 94 1/2 | * & **** | 1982 | (2,800) | VC | WF |
| Schooner Bayou 7 | Parish Govt. | 1982 | 3,700 p,E | FG,PL | MR,WF |
| North Bayou 1 | * | 1983 | 4,100 c,E | FG | MR |
| Mermentau Riv. 151 | Parish Govt. | 1983 | 4,000 | FG | MR |
| Creole Canal # 2 | Cameron Par. GDD4 | 1985 | 3,264 | FG/VC | MR |
| Vermilion Par. W/L 200 | * | 1884 | 3,378 p,E | FG,VC | MR,WF |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects
Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| MERMENTAU: | | | | | |
| Vermilion Par. 197 | * | 1984 | 3,883 | - | WF,MR |
| Vermilion Par. W/L 220 | * | 1985 | 2,260 p,E | VG/FG | MR,WF |
| Cameron Par. W/L 710 | * | 1985 | 279 | FC | WF |
| Cameron Par. W/L 770 | * | 1986 | 400 | VC | WF |
| " " 839 | Cameron Par. GDD5 | 1988 | 960 | FG | MR,WF |
| Vermilion Par. W/L 252 | * | 1989 | 10,396 | - | MR,WF |
| Cameron Par. W/L 887 | * | 1990 | 1,419 | FG | WF |
| Vermilion Par. W/L 260 | * | 1990 | 405 | VC,FG | WF,MR |
| Cameron Par. W/L 906 | * | 1990 | 6,750 | FG,VC | MR |
| Vermilion Par. W/L 285 | * | 1991 | 30,000 *** | SG,FG,VC,LE | MA,MR |
| Cameron Par. W/L 912 | * | 1992 | [800] nw,E | FG/VC | WF |
| " " 1021 | * & **** | 1994 | (850) | - | MF/FB |
| " " 1014 | * | 1995 | 2,700 | - | MR |
| Vermilion Par. W/L 1321 | * | Pend-ing | (36,000) | - | MR |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects
Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| MERMENTAU: | | | | | |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) Sub-total: | (see /1)<br><br>(see ***) | - | 123,864<br>87,344<br>47,435<br>(36,000)<br>(83,435) | - | - |
| CWPPRA Plans: | | | | | |
| ME-02 | none | - | (520) | - | - |
| PME-14 | none | - | (2,742) | - | - |
| PME-15 | none | - | (5,500) | - | - |
| XME-40 | none | - | (4,467) | - | - |
| XME-45 | none | - | (1,000) | - | - |
| XME-46 | none | - | (4,000) | - | - |
| 1) Authorized:<br>2) Modified:<br>3) Pending:<br>4) CWPPRA Plan:<br>5) Totals: | | - | 87,344<br>47,435<br>(36,000)<br>(18,229)<br>(101,664) | - | - |
| | | | | | |
| CALCASIEU/ SABINE: | | | | | |
| Cameron Par. 382 | Cameron Par. GDD3 | 1980 | 66,000 | FC,VC, LE | MR |
| Black Lake 30 | * | 1982 | 768 | VC | WF |
| Cameron Par. W/L 744 | * | 1986 | 6,847 | VC,SG | WF |
| LTMC 59 | * | 1990 | 6,750 | FC,FG | MR,WF |

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TABLE 1.3. (Continued)

Marsh Management and Hydrologic Restoration Projects
Previously Permitted or Currently Planned Under the CWPPRA

| Basin/ Permit # | Applicant | Date | Acres | Struct. type | Purpose |
|---|---|---|---|---|---|
| CALCASIEU/ SABINE: | | | | | |
| LTMC 59 | * | 1990 | 6,750 | FC,FG | MR,WF |
| Cameron Par. W/L 863 | * | 1991 | 800 | VC | MR |
| " " 832 | * | 1991 | 1,373 | FG,VC | WF |
| " " 923 | * | 1992 | 7,224 | PL,FG, VC,LE | MR |
| " " 831 | * | 1992 | 786 | FG,VC | MR |
| " " 963 | Cameron Par. GDD9 | 1992 | 6,575 | FG,VC,L | - |
| Calcasieu Par. W/L 67 | * | 1992 | 35 | - | WF |
| " " 59 | * | 1992 | 700 | LE,C,VC | MR |
| Cameron Par. W/L 987 | * | Pend ing | (2,794) | - | - |
| 1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) CWPPRA Plan:<br>6) Totals: | - | - | 100,652<br>97,858<br>97,858<br>(2,794)<br>N/A<br>(100,652) | - | - |
| | | | | | |
| GRAND TOTALS:<br>1) Applied for:<br>2) Authorized:<br>3) Modified:<br>4) Pending:<br>5) Sub-totals:<br>6) CWPPRA Plan:<br>7) Total: | - | - | <br>594,140<br>542,623<br>461,308<br>(50,997)<br>(549,795)<br>(438,257)<br>(988,052) | - | - |

(See symbols, definitions, and sources on the following page.)

| STRUCTURE TYPE: | PURPOSES: |
|---|---|
| FG= flapgate | WF- Waterfowl/furbearers |
| VC= variable crest weir | MR- Reduce marsh deterioration/ marsh restoration |
| FC= fixed crest weir | RE- Research |
| LE= levee | MA- Mariculture related activities |
| PL= plug | FB- fur bearers |
| C = culvert | |
| SW= slotted weir | |
| SG= screwgate | |

Par.- Parish

W/L- wetland

N/A- Not Applicable or None Available as appropriate.

nw- no work done on the permit issued.

p- partially acted upon

E- expired

( ) - Parentheses ( ) around acreage figures have different meanings at different project sites. The acreage figures for projects with permits still pending are in parentheses. The acreage figures for CWPPRA projects (if known) but not yet permitted are also preliminary, and are therefore shown in parenthesis. Finally, the acreage figures of the Sub-totals and Totals are in parentheses if they include either permits pending or CWPPRA projects not yet approved by regulatory authority. NOTE: The permits of several partially (p) completed projects have subsequently expired (E); however, acreage figures were included in the Sub-totals and Totals. At the present time details regarding their level of completion are not available.

[ ] - Brackets indicate that permits were issued but no work (nw) was done and the permit subsequently expired (E).

-? - Question marks indicate that information on these projects is unknown at the present time.

* - Permits issued to private (rather than public) interests.

** - modified permits

*** - not included in production totals due to its mariculture feature which will be considered in other studies.

****- considered outside of the biological study area

SOURCE: New Orleans District, using information on regulatory permits and plans of the Louisiana Coastal Wetlands Conservation and Restoration Task Force established in response to the CWPPRA.

## 2. INVENTORY OF SOCIOECONOMIC RESOURCE AREAS

2.1. The procedure for evaluating the social and economic effects of the marsh management projects begins with a description of the socioeconomic resources of the affected basin. This section also provides the context for evaluation the cumulative impacts associated with implementing or not implementing marsh management projects. Paragraphs 2.2. through 2.8. provide brief outlines of socioeconomic characteristics in the basins where marsh management projects have been authorized and where additional projects are anticipated as part of the Louisiana Coastal Wetlands Restoration Plan.

2.2. Pontchartrain Basin. Portions of nine parishes lie within the basin, including Ascension and Livingston Parishes which are part of the Baton Rouge Metropolitan Statistical Area (MSA), and St. James, St. John the Baptist, St. Charles, Jefferson, St. Bernard, and Orleans Parishes which are all part of the New Orleans MSA. The total area considered part of the basin covers some 1,700,000 acres; however, three large lakes, Maurepas, Pontchartrain, and Borgne cover 55 percent of the basin. The total marsh loss anticipated over the next 50 years has been projected to be 62,400 acres if no remedial action is taken. While the geographical limits of the basin are the east bank of the Mississippi River and areas along the east side of the Mississippi River Gulf Outlet (MR-GO), the social and economic conditions on the east bank are significantly influenced by conditions on the west bank of the river, particularly in the New Orleans area since both banks are part of the urbanized area. The 1990 census of population in the entire 9-parish area was 1,244,900. Economic developments center around oil and gas production and processing; tourism; waterborne commerce and other port-related construction, maintenance, and commerce; along with other sales, services, and financial activities normally associated with large metropolitan areas. The completion of construction activities generated by the expansion of oil and gas production during the 1960's and 1970's, and the subsequent decline of oil prices and production during the 1980's, have been major factors influencing limited economic growth, high unemployment rates, and outmigration in the area. The commercial harvest of fish and wildlife, and the sale and service of boats and supplies for both commercial and recreational purposes, are also important to the regional economy. Marsh management projects permitted in the area total approximately 37,490 acres, all used at least in part for fish and wildlife production. Two of the projects with marsh totaling 5,842 acres were established for marsh restoration and land loss reduction purposes. Future marsh management projects (all planned for marsh restoration and land loss reduction purposes) would bring the total permitted area to 82,996 acres. They would represent approximately 31 percent of the 267,800 acres of fresh, intermediate, brackish, and saline marsh in the basin reported in 1993. At that time the basin also included 215,600 acres of cypress swamp.

2.3. Breton Sound Basin. The Breton Sound Basin encompasses

approximately 676,400 acres, of which 184,100 acres are wetlands. It is bounded on the west by the Mississippi River, on the north by Bayou La Loutre, on the east by the south bank of the Mississippi River Gulf Outlet, and on the south by Baptiste Collette Bayou and Breton Islands. As indicated in the above table, the four marsh management projects authorized in the basin have had a total acreage of 13,492 acres; however, their permits have since expired. All were planned for purposes of fish and wildlife enhancement and marsh restoration and land loss reduction. No federal commitments have been made for marsh management projects. Without any action marsh loss over the next 50 years is anticipated to be approximately 33,470 acres. These figures reflect the Caernarvon Freshwater Diversion Structure, which is anticipated to reduce marsh loss by 16,000 acres over the next 50 years. The basin includes portions of Plaquemines and St. Bernard Parishes, but only a small portion of the urbanized section of the New Orleans MSA, along the southern boundary of St. Bernard Parish. It incudes a portion of Voting District K which had a total population of 7,271 in 1990. The narrow strip of land in Plaquemines Parish which is part of the basin had a 1990 population of 2,357. The comparatively small population is due to the limited amount of land which is not subject to tidal overflows, flooding, and periodic hurricanes. In addition to commercial fishing, employment opportunities include support port activities and mineral production, primarily oil and gas production.

2.4. Barataria Basin. The basin contains approximately 1,565,00 acres, with portions located in nine parishes, including Assumption, Ascension, St. James, Lafourche, St. John the Baptist, St. Charles, Jefferson, Plaquemines, and Orleans Parishes. The basin drains southward from a point near Donaldsonville, Louisiana between the east bank of Bayou Barataria and the West Bank of the Mississippi River, to a chain of islands which separates the basin from the Gulf of Mexico. The southern half of the basin consists of tidally influenced marshes connected to a large bay system behind the barrier islands. The basin contains 152,120 acres of swamp, 173,320 acres of fresh marsh, 59,490 acres of intermediate marsh, 102,720 acres of brackish marsh, and 133,600 acres of saline marsh. An estimated 175,230 acres of marsh, or about 38 percent of the total wetlands of the area could be loss over the next 50 years. Since 1983, 131,900 acres of marsh management projects have been permitted strictly for purposes of marsh restoration and land loss reduction. Projects totaling another 45,300 acres have been permitted in part for marsh restoration and land loss reduction, and in part to maintain fish and wildlife productivity. Another 51,200 acres of marsh management projects have been permitted strictly for the maintenance of fish and wildlife resources. As indicated in paragraph 2.2.1., a number of the parishes which form at least portion of the basin are part of the New Orleans MSA. The total population of the nine parishes is about 1,241,000. The Barataria Basin is centered west of the New Orleans Central Business District (CBD). The basin also includes part of Lafourche Parish which is one of the parishes making up the Houma MSA. The City of Houma is in Terrebonne Parish, immediately west of

Lafourche Parish. The metropolitan area has experienced the benefits and the difficulties of fluctuations in the oil and gas industries, including declines in employment, income opportunities and population growth during the 1980's. Approximately 209,000 acres of the 235,000 acres permitted for marsh management projects in the basin are located in Lafourche Parish (and east of Bayou Lafourche). More than two-thirds of the 169,000 acres committed for additional marsh management projects in the basin are in Lafourche Parish.

2.5. Terrebonne Basin. The Terrebonne Basin includes all of Terrebonne Parish and parts of Lafourche, Ascension, and Assumption Parishes, and small portions of St. Martin and St. Mary Parishes. Almost all of the permitted marsh management projects in the basin are located in either Terrebonne or Lafourche Parish. The Terrebonne Basin supports about 155,000 acres of swamp, and almost 574,000 acres of marsh of various types and grades. Since 1982 the Corps has permitted approximately 47,800 acres of marsh management projects in this area. About 5,800 acres were not developed before the permits expired. About 41,000 acres of the permitted marsh management projects have been at least in part for purposes of marsh restoration or reductions of land loss. Some 21,000 acres of the projects have been in part for maintenance of fish and wildlife production. While the total acreage of projects planned under CWPPRA programs has not been finalized, an estimated 163,900 acres of marsh management projects in the basin have been identified to date. An estimated 219,500 acres of marsh are anticipated to be loss over the next fifty years under current trends. As discussed in the previous paragraph, Terrebonne Parish is part of the Houma MSA. In 1990 the total population of Terrebonne, Lafourche, Ascension, St. Mary, and Assumption Parishes was about 321,900. Major sources of income and employment have been oil and gas exploration and production, related construction, transportation, and services, and wholesale, retail, and commercial services generated by the production industries. Agricultural production is important in the higher elevations of the basin is also important, including the production of sugarcane, soybeans, grains, and livestock and livestock products.

2.6. Teche/Vermilion Basin. The Teche/Vermilion Basin contains roughly 243,000 acres of wetlands in Vermilion, Iberia, and St. Mary Parishes. Since 1932 about 42,300 acres of marsh have been lost, considered a relatively low rate of loss in comparison with basins further to the east. Approximately 36,750 acres of wetlands are anticipated to be lost over the next 50 years. Marsh management projects permitted since 1981 have totaled approximately 25,200 acres. About 5,100 acres of the marsh have been permitted for the maintenance of fish and wildlife production. About 1,800 acres of marsh have been authorized for marsh restoration; and about 18,300 acres have been authorized for a combination of fish and wildlife maintenance and reductions in land loss. Anticipated CWPPRA projects would result in another 42,000 acres of marsh management projects. The total population of the parishes which are part of the basin had a 1990 population of 176,438. The production of

natural gas and petroleum and related supplies and services have been major sources of employment and income in the basin. The production of rice, sugarcane, livestock, and livestock products, are still important to the local economy.

2.7. Mermentau Basin. The Mermentau Basin lies in the eastern portion of the Chenier Plain in Cameron and Vermilion Parishes. The 734,000-acre basin includes 128,200 acres of publicly owned land used as a Federal refuge and State wildlife management areas. The basin contains about 450,000 acres of wetlands, consisting of 190,000 acres of fresh marsh, 135,000 acres of intermediate marsh, and 101,000 acres of brackish marsh. A total of 104,400 acres of marsh has converted to open water since 1932, a loss of 19 percent of the historical wetlands in the basin. Over the next 50 years an estimated 99,000 acres of marsh have been projected to be lost under present conditions. To date marsh management permits authorized and subsequently modified total 47,400 acres. Projects developed for fish and wildlife maintenance totaled about 7,100 acres. About 20,800 acres have been authorized for marsh restoration; and another 19,500 acres have been authorized for both marsh restoration and fish and wildlife maintenance purposes. A 30,000-acre project has been permitted for both marsh restoration and mariculture related activities but is not included in the sub-totals or totals. Another 18,200 acres of projects are planned under CWPPRA programs. The total population of Cameron and Vermilion Parishes in 1990 was about 59,300. Similar to the other coastal basins, the Mermentau Basin has been an important source of natural gas and petroleum; their benefits to the local and regional economies have declined in recent years as development has been either completed or become costly due to foreign competition. Somewhat like Plaquemines Parish on the eastern end of the State, Cameron Parish is largely wetlands and subject to severe weather conditions; therefore, the potential for population growth is limited in spite of access to abundant natural resources, including oil, gas, and fish and wildlife resources.

2.8. Calcasieu/Sabine Basin. The Calcasieu/Sabine Basin is located in Cameron Parish and includes a small strip of Calcasieu Parish. It consists of approximately 630,000 acres. About 24 percent (148,600) acres of the basin lands is publicly owned as Federal refuges. The basin contains about 312,500 acres of wetlands, consisting of 32,800 acres of fresh marsh, 112,acres of intermediate marsh, 158,200 of brackish marsh, and 9,500 acres of saline marsh. A total of 122,000 acres have been lost since 1932, 28 percent of the marsh that existed in 1932. Another 54,600 acres are projected to be lost if no action is taken. Calcasieu Parish is coextensive with the Lake Charles MSA. While the population of Cameron Parish was only about 9,260, the population of Calcasieu Parish was about 168,100. The economy of the Lake Charles MSA is based on both oil and gas processing, production, and transportation, and regional market trends like other metropolitan areas. The Calcasieu River and Pass waterway provides the city and port of Lake Charles with a 36-foot channel.

3. SOCIOECONOMIC EFFECTS

3.1. Fish and Wildlife Resources.

3.1.1. Commercial.

3.1.1.1. Existing Conditions. As previously indicated, major purposes of marsh management projects regulated by the Corps have been to maintain fish and wildlife resources important for both commercial and recreational purposes. Extensive research by biologists, and more recently fish and wildlife economists, have explained the relationship between the productivity of the Louisiana coastal environment and trends in the level of commercial harvests in the State. As shown in Table 3.1.1.1., Louisiana, on average, accounted for 19 percent of the U.S. total (including Alaska and Hawaii) of commercial fishery landings for the period from 1984 to 1993.

TABLE 3.1.1.1.

U.S. AND LOUISIANA COMMERCIAL LANDINGS

1984-1993 (thousands of pounds)

| YEAR | LOUISIANA | U.S. TOTAL | % OF U.S. |
|---|---|---|---|
| 1984 | 1,931,027 | 6,437,783 | 30 |
| 1985 | 1,704,498 | 6,257,642 | 27 |
| 1986 | 1,699,321 | 6,030,634 | 28 |
| 1987 | 1,803,944 | 6,895,726 | 26 |
| 1988 | 1,356466 | 7,192,553 | 19 |
| 1989 | 1,227,941 | 8,463,080 | 15 |
| 1990 | 1,061,228 | 9,403,571 | 11 |
| 1991 | 1,192,539 | 9,484,194 | 13 |
| 1992 | 1,013,575 | 9,637,303 | 11 |
| 1993 | 1,292,893 | 10,466,895 | 12 |
| TOTAL | 14,283,432 | 80,269,381 | 19 |

Source: U.S. Department of Commerce, National Marine Fisheries Service, "Fisheries of the United States" annual volumes 1984-1993. The vast majority of total pounds of fish and shellfish landed in Louisiana has been menhaden, largely exported and used for industrial purposes, while more of the total value of fishery

landings have been from the harvest of shrimp, oysters, blue crab, crawfish, tuna, red snapper, sea trout, black and red drum, sea catfish, flounder, mullet, and a wide variety of other finfish. Usually more than half of the total value to the fishermen comes from shrimp landings. Menhaden ranks second, followed by blue crab, oysters, tuna, and crawfish. In 1993, the total value of commercial landings in Louisiana as reported by NMFS was $261.8 million. The total value of landings in Louisiana ranked second only to Alaska, with commercial landings valued at $1.4 billion. About 70 percent of the Nation's domestic shrimp landings have been at Gulf ports (NMFS, 1994).

Marine industry professionals have indicated that the productivity of marine fisheries are significantly dependent on the quality and quantity of marine fishery habitat. Louisiana's tidal marshes make up approximately 64 percent of the total along the Gulf of Mexico (U.S. portion) and nearly 40 percent of the costal marshes in the contiguous 48 States. In some cases this habitat has been declining at an alarming rate. Consequently, degradation and habitat loss contribute to fishery declines which, combined with overfishing, could reduce yields.

In addition to the problems associated with declining production, overfishing, and the adverse impacts of deteriorating estuaries, the Gulf commercial fishing industry has experienced the effects of growing competition from foreign markets. For example, the amount of fresh and frozen shrimp imported from 1984 to 1993 has increased from 328,916 thousand pounds valued at about $1.2 billion in 1984 to 592,808 thousand pounds valued at about $2.2 billion in 1993. These figures do not include a substantial level of domestic fishery landings which may go unreported by the fishing industry due to the voluntary procedures used in data collection and the independent traditions of the commercial fishing community. Foreign competitors include developing countries where labor costs tend to be lower and where capital investments may be substantially supported by the governments.

Aquaculture in the United States and competing foreign countries is another significant factor in the market for shrimp, crab, oysters, crawfish, menhaden, and other fishery products. As methods of production have become more efficient and competitive, the potential for aquaculture capturing a greater share of the seafood market has grown. The development of aquaculture has changed the structure of the industry, as well as prices and levels of production, and is likely to remain competitive with more traditional methods of harvest.

Other important issues characterize the setting for the commercial fishing industry in coastal Louisiana. One of these issues has been the federal requirement of shrimpers to use turtle exclusion devices (TED's) which commercial fishermen have found to significantly reduce their catch and therefore net return from previous landings. The amount of bycatch, or the amount of fish shrimpers have been catching and disposing of while harvesting the

more valuable shrimp harvest has been another controversial issue in recent years. The increasing popularity of recreational fishing has had a negative impact on commercial fishing and created substantial controversy. Other sources of controversy have stemmed from fishing bans on popular fish (for example, redfish), the consideration of limited entry, moratoriums, license limitations, and individual quotas.

Despite the intense conflict that has arisen in the fishing industry, the fishing resources still support a wide range of related businesses such a processors and canners, shippers, wholesale and retail operations, restaurants, boats building and repair yards, net and other gear builders, icehouses, and commercial marinas. According to a recent study, the commercial fishing industry in Louisiana creates 90,000 jobs and has an economic impact of $1.5 billion (Keithly, 1991).

Although much less important in terms of the economic significance, furbearers and alligators are also commercially harvested for pelts, hides and meats. After years of closed season, alligator hunting is now legal and commercially productive. Historically Louisiana has been one of the most productive sources of fur in the United States. From 1972 to 1992 the annual harvest of alligator skins increased from 1,350 to an estimated 24,000. The value of an average skin increased from about $55 in 1972 to more than $400 in 1991. The total commercial value of the alligator harvest has increased from about $75.5 thousand to more than $13.5 million (LDWF, unpublished).

While the harvest and value of alligators have increased, the harvest of furbearers has declined. During the 1945-46 season, for example, an estimated 8.3 million muskrat pelts were taken in Louisiana. During the period from 1978 to 1991 the harvest of muskrat pelts averaged 256,692, or less than 0.3 million pelts. As reported by the LDWF, a variety of factors have caused the sharp decline in demand for fur. Among them have been a doubling of worldwide production of ranch mink, several mild winters, market saturation, shifts to alternative products, general economic conditions, and other factors such as the animal rights movement. The decline in demand for furbearers has become and increasing concern not only to the fur industry but landowners who have experienced adverse effect from the overpopulation of certain furbearers. The overpopulation of nutria caused significant damage to rice and sugarcane crops during the 1950's and 1960's. Recently, the overpopulation of muskrat and nutria has been identified as an additional cause of damage to marsh degradation and subsequent wetland loss (Cochran, 1991).

3.1.1.2. No Action. The traditional pattern of commercial fishing is likely to change as the productivity of marshes decline. The marsh management projects planned in response to the CWPPRA may reduce adverse environmental conditions potentially harmful to the commercial fishing industry; however, these projects may need to be carefully monitored to evaluate their effectiveness if adverse

impacts are also anticipated. The effectiveness of the marsh management projects may not be the most significant factor influencing trends in commercial fishing industry. Similar to recent trends, increases from foreign competitors, changes in technology, and declines in the resource base, are factors which could result in a restructuring of the industry over time. As the fishing resources decline, controversy and conflict over allocation of the limited resources could increase. Factors which resulted in a decline in the industry would reduce the positive impacts that the industry currently has on the local and national economies. Losses of income from a reduced level of harvest, processing, sales, and related sales and supplies influencing the industry would result in direct and indirect impacts on the economy of the region.

3.1.1.3. Permit Requirement. Future permit applicants may be required to provide information on the effects which their proposals might have on commercial fishing and trapping, including positive or negative effects. The level of detail needed in evaluating social and economic impacts should be considered based on the level of significance which any individual marsh management project, or series of projects, might have on commercial fishing and trapping.

3.1.2. Recreational.

3.1.2.1. Existing Conditions. Recreational fishing and hunting in Coastal Louisiana have in the past been referred to as the "Sportsman's Paradise" due to the unusual productivity of available resources. Freshwater fish species sought after by anglers include largemouth bass, crappie, blue catfish channel catfish, bluegill sunfish, and redear sunfish. A large and steadily growing number of anglers fish for largemouth bass in the low salinity marshes where productivity rates are high and large numbers of bass are found. Inshore and near-shore saltwater anglers' preferred species include spotted sea trout, red drum, southern flounder, black drum, sheepshead, Atlantic croaker, and sand sea trout. Crabs, shrimp, and crawfish are also a significant part of the recreational fishery. Waterfowl hunting is very popular activity in the coastal wetlands, although reduced bag limits and below average fall flights of popular duck species in recent years have somewhat depressed participation in the sport. Goose hunting is a very popular sport, especially in the western part of the coast. Big and small game animal species such as white-tailed deer, swamp rabbits, and gray and red squirrels, are pursued as well but to a much lesser degree.

Numerous marsh camps, serving as seasonal or weekend bases of operation, are used by many local and out-of-state recreationists as a starting point for various outdoor activities. Many of these camps, which are only accessible by boat, serve as clubhouses for the coastal area's numerous fishing and hunting clubs. Other camps are privately owned and used almost exclusively for family oriented recreation. Several thousand such camps are located in the coastal

area.

The primary users of the recreation resources of the study area are residents of southeastern Louisiana. Current estimates indicate that several million user-days of recreational activity occur in the coastal parishes annually. A study completed in 1984 for the Louisiana State University Center for Wetland Resources (Bertrand, 1984) estimates the 180,000 licensed saltwater sports fishermen in the State annually spend $181 million on fishing and have nearly a billion dollars invested in boats, gear, camps, and other equipment. The study estimates that total annual economic impact of fishing related expenditures at over half a billion dollars. A later analysis, produced by the Sport Fishing Institute, put the total economic impact at nearly $900 million for the year 1985 (Sport Fishing Institute, 1988). In recent years, the economic importance of this recreation group has come to play in the increasing competition between commercial and recreational fishermen, as previously mentioned.

Louisiana is located at the southern end of the Mississippi Flyway, a major waterfowl migratory route. Nearly 70 percent of the ducks and geese that use the flyway overwinter in Louisiana's marshes. The economic value of the hunting provided by the flyway exceeds $10 million annually. Waterfowl hunting, when combined with recreational fishing supported by Louisiana wetlands exceeds 3 million annual user days.

3.1.2.2. No Action. The recreational potential of the coastal wetlands and barrier islands is related to wetland availability. The potential for recreational use will diminish as the wetlands are lost. As these resources decline, controversy and conflict over the allocation of limited resources will likely increase. A significant marsh management consideration identified has been how much public access for recreational fishing and hunting will be available as marsh conditions change.

3.1.2.3. Permit Requirement. Future permit applications will need to consider the positive and negative effects which their proposals could have on recreational fishing and hunting.

## 3.2. Flood Control.

3.2.1. Existing Conditions. Historically the Louisiana coastal region has been subject to periodic high river stages, storms, and hurricanes requiring levee systems to minimize flood damage and the effects of severe wind damage. In 1927, unusually high river stages along the Mississippi River and its tributaries led to construction of an extensive network of Federal flood control projects from Cairo, Illinois to the Gulf of Mexico. Other structures have been established to stabilize river conditions which would otherwise result in an eventual change in the course of the river and send more of its flow down the Atchafalaya. Current flood control projects, however, now tend to reduce the flow of fresh water and

sediment into wetlands and the coastal marshes. The system of levees, in addition to subsidence, compaction, sea level rise, and resultant changes in vegetation, expose the coastal marshes to the erosive tidal environment. This problem is compounded in many locales where artificial channels dredged for navigation and oil and gas development. They provide conduits for seawater to penetrate far inland, and to drain rainfall rapidly seaward. These conditions, along with other structural activities for economic development, and the cycles of drainage, natural and otherwise, have contributed to increasing rates of coastal erosion and deterioration of the marshes.

A single flooding event in coastal Louisiana could be caused by any combination of three factors: local rainfall, high river stages, or tidal flooding including hurricane surges. There is a widespread view among the general public and many professionals that coastal wetlands provide protection from storm surge and thereby lower stage increases experienced in communities inland from the coast. This seems logical based on gauge readings taken during hurricanes which in general show decreasing peak stages the farther distance from the gulf the gauges are located. The degree to which coastal wetlands can ameliorate tidal surge is probably dependent on the extent and configuration of the wetlands and the path and strength of particular storms and should be addressed in future marsh management permit applications.

3.2.2. No Action. While current coastal wetland restoration plans and related marsh management projects will not completely deter flooding effects from coastal erosion, an initial plan of action is in place. The marsh management projects that include a marsh restoration feature are expected to reduce the rate of net land loss and contribute to stability of adjacent developed areas which, over time, would be more subject to the effects of flooding caused by high river stages, subsidence, erosion, sea level rise, and severe weather conditions.

The Louisiana Coastal Wetlands Restoration Plan anticipates that existing levee systems would be maintained and upgraded as needed to provide populated areas with protection from hurricane flooding. Additional hurricane protection levees would likely be constructed especially on the west bank of the Mississippi River in the vicinity of New Orleans and in Terrebonne and Plaquemines Parishes. Long-term effects of global sea level rise coupled with regional subsidence would make gravity drainage systems work less efficiently and would subject unprotected areas to greater chances of flooding.

3.2.3. Permit Requirement. Permit applicants should consider the potential effects which their proposals might have on existing flood control systems. If applicants feel that their proposals could have a net beneficial effect on flood control conditions, supporting documentation may be required. Any additional information available should be provided as soon as possible.

### 3.3. Land Use and Land Loss.

3.3.1. Existing Conditions. Most of the marsh management projects which are not designed exclusively for the maintenance of fish and wildlife resources are for marsh restoration purposes and the reduction of land loss. A major function of marsh restoration and the prevention of land loss is to avoid the effects of land loss further inland. Another concern of property owners in the past has been the potential loss of mineral rights. Traditionally waterbottoms have been considered public property; therefore, the owners of areas which had previously been marsh have identified the need to make certain that their mineral rights have not been lost along with the marsh. The economic considerations regarding mineral rights could be extremely significant since coastal Louisiana has been one of the nation's most productive sources of petroleum and natural gas. Other land loss and land use considerations are the effects changing marsh conditions might have on property further inland. As the marshes subside and erode, lands further inland tend to more subject to increasing salinity levels, which could reduce the value of adjacent agricultural lands. If marsh management projects reduce the effects of subsidence, erosion, and sea level rise which might otherwise result in the cost of maintaining other land uses, e.g. residential, commercial, and industrial uses, the projects could have benefits on more urban activities.

Table 3.3.1. on the following page summarizes an estimate of land use in the coastal region as described in the EIS for the Louisiana Coastal Wetlands Restoration Plan completed in 1993. As indicated in the report, the acreage figures in the table are not intended to represent current wetland analyses but to give readers additional understanding of current land use conditions. The 1993 EIS estimated that more than 900,000 acres of wetlands were lost between 1932 and 1990. An additional 768,000 acres were estimated to be lost by 2040 if no action were taken by property owners or the public. As indicated in Section 1, action has been taken and plans to reduce marsh loss have been developed.

3.3.2. No Action. While marsh management projects have been developed in response to the CWPPRA, only part of them have been implemented. Those which appear to have substantial public support and are anticipated to be completed over the next fifteen years are expected to reduce past rates of land loss. As indicated in Table 1.3., the identified acreage of marsh management projects currently existing, partially completed, or planned total 988,052 acres.

3.3.3. Permit Requirement. Applicants should identify positive and negative effects which their proposals might have on land use and land loss. They should be prepared to provide adequate documentation to support claims that their proposals would have significant positive effects on land use and/or land loss.

TABLE 3.3.1.

# 1980 ESTIMATES OF LAND USE IN THE LOUISIANA COASTAL AREA

| PARISH/MSA[1/] | TOTAL LAND AREA | RESIDENTIAL LAND | COMMERCIAL & SERVICE LAND | INDUS-TRIAL LAND | TRANS., COMM., & REL. SRVS. | MIXED URB. & BLT-UP LAND | AGRICULT. LAND | FOREST LAND | STRIP MINES & QUARRIES | TRANSI-TIONAL AREA | WETLANDS & BEACHES |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Baton Rouge MSA**[1/] | | | | | | | | | | | |
| ASCENSION | 187,689 | 13,204 | 1,359 | 3,413 | 2,149 | 62 | 73,961 | 40,586 | 232 | 772 | 51,351 |
| LIVINGSTON | 417,151 | 27,042 | 1,328 | 185 | 2,054 | 77 | 43,474 | 289,818 | 1,019 | 2,116 | 70,038 |
| **Houma MSA** | 1,504,729 | 24,030 | 5,127 | 2,362 | 1,869 | 3,398 | 175,904 | 1,730 | 15 | 1,313 | 1,288,981 |
| LAFOURCHE | 705,377 | 12,787 | 2,054 | 571 | 834 | 1,004 | 121,573 | 1,622 | 15 | 488 | 564,469 |
| TERREBONNE | 799,352 | 11,243 | 3,073 | 1,791 | 1,035 | 2,394 | 54,331 | 108 | - | 865 | 724,512 |
| **Lafayette MSA**[1/] | | | | | | | | | | | |
| ST. MARTIN | 486,370 | 11,567 | 571 | 1,467 | 1,421 | 201 | 125,001 | 74,578 | - | 1,900 | 269,664 |
| **Lake Charles MSA** | 691,077 | 29,621 | 4,649 | 10,224 | 4,448 | 1,421 | 315,948 | 208,043 | 216 | 6,733 | 109,774 |
| CALCASIEU | 691,077 | 29,621 | 4,649 | 10,224 | 4,448 | 1,421 | 315,948 | 208,043[2/] | 216 | 6,733 | 109,774 |
| **New Orleans MSA** | 2,131,081 | 124,817 | 25,544 | 25,374 | 23,844 | 13,049 | 202,453 | 307,223 | 5,790 | 24,032 | 1,378,955 |
| JEFFERSON | 204,522 | 30,579 | 7,475 | 6,116 | 4,355 | 4,602 | 2,456 | 124 | 154[3/] | 1,220 | 147,441 |
| ORLEANS | 115,719 | 26,702 | 8,942 | 2,517 | 4,602 | 4,386 | 664 | 7,722 | 108 | 1,405 | 58,671 |
| PLAQUEMINES | 502,788 | 7,768 | 2,008 | 4,510 | 3,691 | 1,313 | 19,012 | 13,853 | 1,745[3/] | 5,591 | 443,297 |
| ST. BERNARD | 282,096 | 6,502 | 1,127 | 1,637 | 31 | 46 | 1,915 | 7,923 | 170 | 5,622 | 257,123 |
| ST. CHARLES | 176,444 | 4,849 | 1,127 | 4,386 | 1,405 | 865 | 20,865 | 571 | 77 | 1,869 | 140,430 |
| ST. JAMES | 151,472 | 5,035 | 402 | 3,382 | 1,189 | 61 | 52,601 | 1,560 | 77 | 541 | 86,624 |
| ST. JOHN BAPTIST | 141,031 | 5,220 | 571 | 2,363 | 2,224 | 278 | 23,505 | 726 | 46 | 664 | 105,434 |
| ST. TAMMANY | 557,009 | 38,162 | 3,892 | 463 | 6,347 | 1,498 | 81,435 | 274,744[2/] | 3,413 | 7,120 | 139,935 |
| **Non-MSA Parishes** | | | | | | | | | | | |
| ASSUMPTION | 218,745 | 5,143 | 463 | 649 | 587 | 155 | 74,299 | 2,069 | - | 124 | 135,258 |
| CAMERON | 799,786 | 2,069 | 386 | 5,529 | 293 | 201 | 139,581 | 2,873 | 1,112[3/] | 880 | 646,862 |
| IBERIA | 375,238 | 11,367 | 2,363 | 1,498 | 865 | 463 | 121,110 | 15,691 | 201 | 93 | 221,587 |
| ST. MARY | 399,098 | 7,104 | 1,189 | 2,425 | 1,761 | 4,093 | 96,693 | 1,745 | - | 278 | 283,810 |
| TANGIPAHOA | 508,732 | 25,729 | 3,351 | 942 | 5,791 | 479 | 158,778 | 231,425[2/] | 4,695 | 2,486 | 75,056 |
| VERMILION | 738,272 | 12,479 | 1,050 | 973 | 432 | 170 | 377,862 | 21,899 | 46 | 479 | 322,882 |
| TOTAL STUDY AREA | 8,457,968 | 294,172 | 47,380 | 55,041 | 46,114 | 23,769 | 1,905,064 | 1,177,680 | 13,326 | 41,206 | 4,854,216 |

1/ MSA- Metropolitan Statistical Area. Baton Rouge MSA also includes East and West Baton Rouge Parishes. Lafayette MSA also includes Acadia, Lafayette, and St. Landry Parishes.
2/ Includes Shrub and Brush Rangeland: Calcasieu, 5,884 acres; St. Tammany, 2,826 acres; and Tangipahoa, 170 acres.
3/ Includes Sandy Areas other than Beaches: Cameron, 1,112 acres; Jefferson, 154 acres; and Plaquemines, 618 acres.
SOURCE: State of Louisiana, Department of Transportation and Development; and Louisiana Office of State Planning. Preliminary and unpublished.

3.4. Mineral Production.

3.4.1. Existing Conditions. The consideration of mineral production may be significant in evaluating the potential effects of a marsh management project because Louisiana's coastal marshes have been a very important source of the nation's petroleum, natural gas, and other minerals. An extensive network of channels and canals has been dredged through the marshes in the development of these important natural resources. Their abundance, and the technology developed in harvesting these resources, have been important to the current level of the nation's economic and social well being. On the other hand, the effects of their production and transportation appear to have contributed to the deterioration of existing levels of marshes and therefore may be significant in evaluating the effects of marsh management projects in general, as well as the effects of a marsh management project at a particular site.

3.4.2. No Action. While the additional marsh management projects planned in response to the CWPPRA are expected to reduce the rate of land loss in areas where it is occurring, the continued loss, even at the lower rates, could remain a source of controversy at individual sites as a result of the continuing demand for oil and gas.

3.4.3. Permit Requirement. Future permit applications for marsh management projects will need to consider positive and negative effects of mineral production in the area. As appropriate, applicants may need to furnish information regarding the current and future significance of mineral resources which have been important to the area as sources of energy, tax revenue, business and industry, employment, and income.

3.5. Displacement of Farms.

3.5.1. Existing Conditions. The displacement of farms is an issue which may be significant in evaluating marsh management projects because continued marsh loss, in some areas, could impact farms further inland. As barrier islands continue to deteriorate, and subsidence and land loss continues, salinity levels are likely to increase in areas further inland. These conditions could leave farms closest to the shore more exposed to the effects of storm damage and the effects of salinity. Increases in salinity in lakes and bays adjacent to crops like rice which have depended on the abundance of freshwater in these lakes and bays for production could eventually require costly adjustments in their production methods or relocation. Other important crop produced in the upland areas is sugar cane. Comparatively small quantities of soybeans and wheat for grain are also harvested in upland areas of some of the coastal parishes.

3.5.2. No Action. Existing marsh management projects contribute to reducing the threat of land loss in the coastal marshes, thereby

reducing the probability of damage to property in adjacent areas, including farmland and agricultural buildings and equipment.

3.5.3. Permit Requirement. The impact of future projects on agricultural potential, if within the coastal environment, should be addressed in detail.

## 3.6. Other Businesses and Industries.

3.6.1. Existing Conditions. Similar to mineral production and agriculture, other businesses and industries may be significant in evaluating the effects of marsh management projects regulated by the Corps. These businesses may be in support of commercially harvested fish and wildlife, mineral production, or agriculture, or simply located in the vicinity of communities potentially threatened by the effects of land loss. As discussed in Section II, a wide variety of businesses and industries are located in the protected areas within the Pontchartrain Basin and portions of the Barataria Basins, along the Mississippi River and in the New Orleans metropolitan area.

3.6.2. No Action. While existing and anticipated CWPPRA projects should reduce the potential for land loss trends influencing businesses and industries in the coastal region, in areas where coastal erosion and subsidence continues nearby businesses could be threatened and will need either additional protection or may eventually decide to relocate.

3.6.3. Permit Requirement. Individual permit applications are unique and will need to be evaluated in the context of the overall CWPPRA program, cases conditions of individual basins, and business and industrial trends other than those dependent on mineral production, as appropriate.

## 3.7. Property Values and Ownership.

3.7.1. Existing Conditions. Property values and the protection of property ownership are major factors to be considered in evaluating marsh management projects. Major purposes of the marsh restoration projects are to protect the marshes and thereby maintain their value for current owners. The State of Louisiana traditionally claims ownership of adjacent waterbottoms. In the past, property owners have been concerned over increased regulation of the wetlands and the potential loss of their property as the wetlands have subsided or eroded, to become open water. Property owners further inland have indicated concern over the potential for a declining value in their property, in part due to a potential increase in the cost of protecting their property or the gradual decline in its current and desired utility.

3.7.2. No Action. Existing and planned marsh management projects should result in an overall reduction in the rate of land loss, and

help stabilize adverse conditions associated with declining property values and controversy over issues of ownership. The reduction will be more in terms of reducing the level of adverse impacts rather than a complete solution to the problems since subsidence and erosion is expected to continue but at lower rates.

3.7.3. Permit Requirement. This issue should be fully addressed in future marsh management permit applications. Applicants should recognize the differing views on related issues and be prepared to address their positions and explain how their positions are consistent with overall public as well as private objectives in areas influenced by drainage conditions subject to federal regulation. Recognizing this requirement early on in the review process may significantly reduce time and related costs both to the applicant and the regulating authority.

## 3.8. Public Facilities and Services.

3.8.1. Existing Conditions. Public facilities and services which influence or might be influenced by the demand for marsh management projects are related to federal and State agencies that are responsible for the development and protection of fish and wildlife resources; the flood control structures and services previously mentioned; hurricane evacuation and emergency programs; the Gulf Intracoastal Waterway (GIWW), the Mississippi River and Calcasieu River deep draft navigation channels, and numerous other lesser channels in between which provides access between the GIWW and the Gulf; related programs for environmental mitigation; roads; bridges; schools; as well as the same general network of local, State, and federal public institutions which provide public access for other facilities and services.

3.8.2. No Action. Although the existing and anticipated marsh management projects are expected to reduce adverse impacts which would otherwise affect these facilities and services, plans are based on probabilities for conditions over a limited period of time and assume continued land loss, although at reduced rates. Land loss and associated impacts to public facilities and services in lower elevations would continue at higher rates if the programs planned under the CWPPRA programs were not implemented.

3.8.3. Permit Requirement. At a minimum, these public resources should be identified and impacts assessed. If a permit proposal could adversely affect social or economic conditions, the review process should identify public facilities and services and the level of significance of adverse impacts.

## 3.9. Employment/Labor Force.

3.9.1. Existing Conditions. Employment associated with marsh management projects ranges from work involved in construction and maintenance of related structures to the more indirect effects of

employment conditions influenced by the project. While the immediate effects of creating a project might seem positive, the long range net effects of a project might be either positive or negative, depending on the success of the project and possible adverse effects a project might have on overall economic conditions in the area, including the employment potential of an area. Evaluating the existing conditions of a particular proposal may be limited to describing general employment conditions of a project area, or employment condition of communities, parishes, or metropolitan areas in closest proximity to the project site. If businesses have been affected by a particular project, the related employment has been affected as well.

3.9.2. No Action. Existing marsh management projects and the CWPPRA programs planned for Louisiana coastal wetlands should help to maintain businesses and industries in communities threatened by continued land loss, and thereby help to stabilize employment conditions in these areas.

3.9.3. Permit Requirement. Future permit applicants for marsh management projects should be prepared to identify the potential positive and negative effects of their proposals. In some cases specific information may be required, including favorable or unfavorable employment conditions which could influence, or could be influenced by, marsh management projects. In such cases employment in industries particularly affected should be identified.

3.10. Income.

3.10.1. Existing Conditions. Income is an important factor in evaluating the impacts of marsh management projects when such projects can facilitate the continuation of income in a community and subsequently contribute to overall national economic development. As discussed in the Louisiana Coastal Wetlands Restoration Plan, the 20 parishes which formed the study area had a 1990 per capital personal income of $15,610, somewhat higher than per capital personal income for the State which was $14,530. Per capita personal income for the 20-parish area in 1993 was $17,240, higher than the $16,612 per capita personal income for the State (April, 1995 "Survey of Current Business" U.S. Department of Commerce). The 1993 per capita personal income of the primary ten coastal parishes was about $16,780. If the highly urbanized Jefferson Parish is excluded, the 1993 per capita personal income of the 9 remaining parishes is $14,700, significantly below the $16,660 figure reported for the entire State. The lower incomes of the coastal parishes could be partially due to the lingering effects of the depressed oil economy; however, other factors may be the trend toward more automated methods of agricultural and fishery production, and the desire of residents to remain in their unique cultural environment despite in the national economy.

3.10.2. No Action. The absence of additional marsh management

projects would contribute to a gradual decline of total income in areas potentially threatened by the continuation of storms, flooding, and land loss.

3.10.3. Permit Requirement. Current regulations regarding the review of permit applications indicate that benefit-cost analyses or estimates of net income from permitted activities are generally not required; however, applicants may want to explain the anticipated benefit of a proposed project in terms of revenue or income which might be generated by a plan, or anticipated revenue which might otherwise be lost if a marsh management project is not permitted.

3.11. Displacement of People.

3.11.1. Existing Conditions. The existing marsh management projects for purposes of reducing land loss, and those planned under the auspices of the CWPPRA, should reduce the potential for the displacement of people either due directly from land loss or indirectly from the decline in economic activity resulting from land loss. Since current plans do not involve a complete reversal of a trend toward continued land loss, net outmigration and displacement of people can be anticipated over time. Table 3.11.1. on the following page summarizes population trends in the 20 parishes included in the 1993 study for the Louisiana Coastal Wetlands Restoration Plan. The 1993 study estimated that approximately 23,000 people living in communities along the coast might require relocation by 2040 if no action was taken to reduce land loss. Many more people might be displaced as a result of the disruption of economic activities. While some of the land within parishes along the coast is well above elevations which could be considered marsh, all of the people living in the parishes are influenced, to one degree or another, by the coastal wetlands and marshes requiring federal regulation.

3.11.2. No Action. No action would result in a continuation of existing trends, i.e., continued outmigration due to land loss although at somewhat lower rates than indicated prior to the establishment of the CWPPRA.

A recent report ("A White Paper: The State of Louisiana's Policy for Coastal Restoration Activities", April 24,1995) prepared by the Governor's Office of Coastal Activities and the State Department of Natural Resources identified areas of concern with current coastal restoration activities and proposed an alternative strategy for responding to land loss. In the report, it was asserted that current wetland loss rates could result in the abandonment of parts of Louisiana's coastal zone and the relocation of communities to areas further inland within 15 years. It states that "without the immediate implementation of large scale offensive projects, the coast cannot be saved" and that the inevitable displacement of people would be enormously expensive for the state. The marsh management projects planned under the CWPPRA should reduce the rate

TABLE 3.11.1.

## TOTAL POPULATION FOR METROPOLITAN STATISTICAL AREAS (MSA) AND PARISHES IN THE PROJECT AREA

| | 1960 | 1970 | 1980 | 1990 |
|---|---|---|---|---|
| Baton Rouge MSA[1/] | | | | |
| Ascension | 27,927 | 37,086 | 50,068 | 58,214 |
| Livingston | 26,974 | 36,511 | 58,806 | 70,526 |
| Houma MSA | | | | |
| Lafourche | 55,381 | 68,941 | 82,483 | 85,860 |
| Terrebonne | 60,771 | 76,049 | 94,393 | 96,982 |
| MSA total | 116,152 | 144,990 | 176,876 | 182,842 |
| Lafayette MSA[2/] | | | | |
| St. Martin | 29,063 | 32,453 | 40,214 | 44,097 |
| Lake Charles MSA | | | | |
| Calcasieu | 145,475 | 145,415 | 167,223 | 168,134 |
| New Orleans MSA | | | | |
| Jefferson | 208,679 | 338,229 | 454,592 | 448,306 |
| Orleans | 627,525 | 593,471 | 557,927 | 496,938 |
| Plaquemines | 22,545 | 25,225 | 26,049 | 25,575 |
| St. Bernard | 32,186 | 51,185 | 64,097 | 66,631 |
| St. Charles | 21,219 | 29,550 | 37,259 | 43,437 |
| St. James | 18,369 | 19,733 | 21,495 | 20,879 |
| St. John | 18,439 | 23,813 | 31,924 | 39,996 |
| St. Tammany | 38,643 | 63,585 | 110,869 | 144,508 |
| MSA total | 987,605 | 1,144,791 | 1,304,212 | 1,286,270 |
| Non-MSA Parishes | | | | |
| Assumption | 17,991 | 19,654 | 22,084 | 22,753 |
| Cameron | 6,909 | 8,194 | 9,336 | 9,260 |
| Iberia | 51,657 | 57,397 | 63,752 | 68,297 |
| St. Mary | 48,833 | 60,752 | 64,253 | 58,086 |
| Tangipahoa | 59,434 | 65,875 | 80,698 | 85,709 |
| Vermilion | 38,855 | 43,071 | 48,458 | 50,055 |
| TOTAL PROJECT AREA | 1,556,965 | 1,796,189 | 2,085,980 | 2,103,243 |

1/ The current Baton Rouge MSA also includes East and West Baton Rouge Parishes.
2/ The current Lafayette MSA also includes Acadia, Lafayette, and St. Landry Parishes.

Source: U.S. Department of Commerce, Bureau of the Census.

of land loss at many locations; however, current plans are not expected to entirely prevent the gradual deterioration of the Louisiana coastline.

3.11.3. Permit Requirement. Any additional marsh management projects should consider how the project might impact possible displacement of people if any; or, if the project is expected to reduce land loss and prevent adverse impacts to drainage conditions in adjacent areas, the applicant should explain how these conditions might affect potential displacement of people. The applicant should specify the number of people living in communities in the vicinity of the project site who might be affected by the project.

### 3.12. Tax Revenues.

3.12.1. Existing Conditions. The existing and planned marsh management projects could be important if they help prevent land loss, support economic development as previously discussed, and thereby support the local tax base of a community and the Gulf coast region.

3.12.2. No Action. A moratorium on marsh management projects beyond those currently issued and already planned could eventually lead to a weakening of the tax base in communities whether land loss continues to occur, or not.

3.12.3. Permit Requirement. Applicants should consider how their marsh management projects could affect the local tax base of nearby communities. For example, the applicant should consider whether or not the marsh management project could reduce the productivity of commercially harvested fish and shellfish, or reduce the productivity of sport fish and wildlife, in ways which could eventually impacted the local economy and subsequently affect the tax base of a nearby community. These effects may appear incremental but could be significant when combined with other marsh management projects in the same general vicinity.

### 3.13. Community and Regional Growth.

3.13.1. Existing Conditions. Marsh management projects which contribute, either directly or indirectly, to continued economic development in areas along the coast, may have a net beneficial impact on community and regional growth. Conversely, if a project is determined to have a net adverse effect on resources valuable to a community or region, the net effect could be adverse.

3.13.2. No Action. Even if no additional permits are issued beyond those already anticipated, the total amount of additional marsh management acreage will increase substantially, reducing the rate of land loss, helping to stabilize conditions which would otherwise result in continued land loss. Since these projects are planned to

reduce the rate of decline of marsh and wildlife habitat, rather than reverse this trend, their net effect on community and regional growth may be more to retard the recent trend of decline in these areas, rather than enhance growth in areas immediately adjacent to project sites. Urban areas further inland may receive more benefit with respect to community and regional growth, since these more protected areas have greater potential for economic growth.

3.13.3. Permit Requirement. Applicants should be advised that their applications may be considered in relationship to overall community and regional development trends influenced by marsh management projects and that both positive and negative effects, if any, will be considered.

3.14. Health and Safety.

3.14.1. Existing Conditions. Marsh management projects may contribute to the health and safety of communities and the region to the degree that they may reduce land loss and flood hazards as discussed in paragraph 3.2., and subsequently help to maintain the health and safety in the region.

3.14.2. No Action. If no additional marsh management projects are developed which effectively reduce land loss in the coastal region, health and safety problems could eventually arise, as the threat of flooding and storm damage in populated areas gradually increased.

3.14.3. Permit Requirement. Applicants for future permits should be advised that positive and negative health and safety effects of their project will be considered; and if any significant factors are identified they may be required to provide related information.

3.15. Community Cohesion.

3.15.1. Existing Conditions. Community cohesion is the force which creates social bonds within a community. It may be characterized through many forms, including religion, ethnic background education, income, recreation, or other factors considered of mutual economic or social benefit. The availability of an abundant source of fish, shellfish, and wildlife, for both commercial and recreational purposes, has been important to a broad spectrum of groups throughout the coastal area. The cooperative efforts of the citizens of local communities and regions during flood emergencies and hurricane evacuations have also contributed to the overall community cohesion of groups within the area. On the other hand, the differing interests and needs of various elements of the community can cause friction and reduce overall community cohesion. Federal guidelines require that appropriate local, State, and federal authorities review all permit applications for marsh management projects before the permits can be granted. Public notices are also circulated to give interested parties an opportunity to comment on marsh management proposals. The level of

cooperation expressed by groups and individuals with differing interests but participated on the Louisiana Coastal Wetlands Conservation and Restoration Task Force is an example of community cohesion.

3.15.2. No Action. The mutual interests and socioeconomic viability of communities along the coast could decline as land loss in the marshes continue and the potential of developed areas nearby tend to decline. The ultimate success of the CWPPRA projects will depend not only on the success of planning concepts of the program but cooperation within the communities affected.

3.15.3. Permit Requirement. Future applicants need to consider how their marsh management project could influence the overall needs of nearby communities as reflected by public officials, comments from the individuals and organizations responding to public notices, comments at public hearings, or comments in response to any related public documents (EA's, EIS's, etc.).

3.16. Aesthetics.

3.16.1. Existing Conditions. Aesthetic characteristics of areas where marsh management projects are located include the unique rural landscapes that reflect the lifestyles and traditions of different groups within communities along the coast; the vast expanse of wetlands, only sparsely populated by humans, densely populated by plants and wildlife; the winding bends of the Mississippi River and other waterways; and extensive network of lakes and bays which lead to the sounds and barrier islands and Gulf of Mexico.

3.16.2. No Action. While many of the wetland areas of coastal Louisiana, and their aesthetic values, will continue to decline as the effects of subsidence, erosion, and land loss continue, the plans developed by the CWPPRA should reduce adverse impacts. Since the marsh management projects are planned to reduce and not eliminate adverse effects, the decline in aesthetic values associated with the wetlands can be expected to continue, although at somewhat lower rates.

3.16.3. Permit Requirement. The review process will involve consideration of aesthetic values, including unique qualities of the marsh which many people find scenic. Future applicants should identify positive and/or negative effects of their marsh management projects.

3.17. Noise.

3.17.1. Existing Conditions. Noise is essentially sound without value, intrusive, or otherwise objectionable. General standards for measuring noise have been developed and quantified by the U.S. Department of Housing and Urban Development (HUD). Average weighted

sound levels are expressed in decibels (dBA). HUD has estimated that noise levels which are greater than 65 Ldn (noise level, day/night) are "normally unacceptable". It has estimated that any level greater than 75 Ldn is unacceptable without adequate protection. The U.S. Occupational Safety and Health Administration (OSHA) requires employers to assist their employees in protecting themselves against the effects of unacceptable noise levels. OSHA standards apply within areas where future projects might develop. Since the coastal wetlands are largely unpopulated by humans, threats to human health in areas where marsh management projects might be developed appear unlikely.

3.17.2. No Action. No significant adverse impacts to human health are anticipated as a result of noise associated with marsh management projects. Most marsh management projects are in relatively remote areas.

3.17.3. Permit Requirement. Future projects will require the consideration of any noise impacts, however temporary, associated with construction activities and the application of State and Federal requirements.

3.18. Relationships Between Socioeconomic Effects.

3.18.1. Existing Conditions. Evaluating the private and public needs of marsh management projects and significant social and economic effects involve consideration of individual parameters and their combined relationships. In some instances the significance of these relationships are limited and easily apparent; in other instances the significance and implications of a project are more involved. A marsh project managed primarily for the purpose of maintaining wildlife habitat during authorized periods of sport hunting may have socioeconomic conditions which relate not only to recreation but to land use and land loss, property values and ownership, health and safety, or other factors. The construction of a large project which has been developed for marsh restoration as well as fish and wildlife maintenance might have additional implications, including flood control, displacement of people, employment and income, business and industrial activity, the tax base of nearby communities, or protection of the unique and aesthetic characteristics of the environment. Long range implications of a project could be the ways in which the marsh management project influenced adjacent community and regional growth and the viability of commercial and recreational fishing and hunting in the immediate and surrounding areas.

3.18.2. No Action. As indicated in paragraph 1.2. of this report, marsh management projects requiring COE regulatory permits will be subject to the provisions of NEPA which requires the consideration of cumulative effects and the significance of socioeconomic relationships.

3.18.3. Permit Requirement. Future applicants should consider the

significance of individual socioeconomic parameters, their relationships to each other, their net effects, and the cumulative effects of overall hydrologic trends including other permit actions previously documented.

NOTE: Attached is a list of data sources used in developing the socioeconomic elements of the 1993 report for the Louisiana Coastal Wetlands Restoration Plan. These sources may be useful in preparing socioeconomic evaluations of marsh management projects.

BIBLIOGRAPHY FOR THE MAIN REPORT

Carney, David F. and Jean R. Watson. "Wetland Initiatives in Coastal Louisiana". Paper presented at the 27th Annual Conference and Symposium of the American Water Resources Association in New Orleans, La., 1991.

Costanza, Robert and Stephen C. Farber. *The Economic Value of Coastal Wetlands in Louisiana.* Final Report to the Coastal Protection Section, Louisiana Department of Natural Resources, for the Project Titled: Benefits and Costs of Environmental Enhancement Projects in Louisiana. Louisiana State University. 1985.

Keithly, Dr. Walter. *Louisiana Seafood Industry Study.* Louisiana Seafood Promotion and Marketing Board. 1991.

Lam, Manuel. Louisiana Department of Natural Resources, Technology Assessment Division, Baton Rouge, Louisiana. Memoranda summarizing crude petroleum and natural gas production trends in Louisiana and adjacent Outer Continental Shelf (OCS) areas, furnished by FAX to the New Orleans District, CELMN-PD-EW, 1993.

Lindall, W.M., J.R. Hall, J.E. Sykes, and E.L Arnold, Jr. *Louisiana Coastal Zone: Analyses of Resources and Resource Development Needs in Connection with Estuarine Ecology.* Section 10 and 13 - fishery resources and their needs. Prepared by National Marine Fisheries Service Biological Laboratory, St. Petersburg, Florida, for the Department of the Army, New Orleans District, Corps of Engineers. 1972.

Louisiana State University. *Aquanotes.* Sea Grant College Program. Volume 12, Issue 1. 1983.

Pulsipher, A.G., and R.H. Baumann. *Louisiana Petroleum Refining Industry.* Louisiana State University. Center for Energy Studies. p.iii. 1993.

Scott, Loren C. *The Chemical Industry in Louisiana, Economic Profile.* Louisiana Chemical Association. 1993.

State of Louisiana, Office of State Tourism. Unpublished data estimating employment and income generated by tourism. 1991.

U.S. Department of Commerce, Bureau of the Census. *1990 Census of Population and Housing.* "Summary Population and Housing Characteristics, Louisiana". 1990 CPH-1-20. 1991.

U.S. Department of Commerce, National Marine Fisheries Service. *Fisheries of the United States 1991.* Current Fishery Statistics No. 9100. 1992.

BIBLIOGRAPHY FOR THE MAIN REPORT

U.S. Department of Commerce, National Marine Fisheries Service. Southeast Fisheries Center, Miami, Florida. Unpublished preliminary estimates of commercial fishery landing in the west coast of Florida, and the states of Alabama, Mississippi, Louisiana, and Texas. 1989 and 1993.

U.S. Department of Energy, Energy Information Administration. *Natural Gas Annual 1991.* 1992.

Urban Systems, Inc. Unpublished study estimating annual visitation rate. 1993.

White, C.J. State of Louisiana, Department of Wildlife and Fisheries. Memorandum to the New Orleans District estimating unreported commercial fishery landings, unpublished. 1983.

BIBLIOGRAPHY FOR THE EIS

American Petroleum Institute. *Petroleum Facts and Figures.* Washington, DC: Government Printing Office. 1971.

Bertrand, A. L. *Marine Recreational Finfishermen in Louisiana.* Prepared for Coastal Ecology and Fisheries Institute Center for Wetland Resources Louisiana State University, Baton Rouge Louisiana. LSU-CEFI-84-26. 1984.

Cochran, Abe. "New Directions for the Fur Industry" pp.26-29. Louisiana Department of Wildlife and Fisheries, Louisiana Conservationist, Volume 43. March/April 1991.

Keithly, Dr. Walter. *Louisiana Seafood Industry Study.* Louisiana Seafood Promotion and Marketing Board. 1991.

Lam, Manuel. State of Louisiana, Department of Natural Resources, Technology Assessment Division. Memoranda summarizing crude petroleum and natural gas production in Louisiana and adjacent Outer Continental Shelf (OCS) areas, furnished by FAX to the New Orleans District, CELMN-PD-EW. 1993.

Lindall, W.M., J.R. Hall, J.E. Sykes, and E.L. Arnold, Jr. *Louisiana Coastal Zone: Analyses of Resources and Resource Development Needs in Connection with Estuarine Ecology.* Section 10 and 13- fishery resources and their needs. Prepared by National Marine Fisheries Service Biological Laboratory, St. Petersburg, Florida, for the Department of the Army, New Orleans District, Corps of Engineers. 1972.

*Louisiana Almanac, 1988-89.* Milburn Calhoun, Ed. Pelican Publishing Company. 1988.

Louisiana State University, *Aquanotes.* Sea Grant College Program. Vol. 12, Issue 1. 1983.

Sport Fishing Industry in cooperation with the U.S. Department of the Interior, U.S. Fish and Wildlife Service. "The Economic Impact of Sport Fishing in the State of Louisiana". Washington, D.C. 1988.

State of Louisiana, Department of Labor. Unpublished monthly and annual reports of the estimated civilian labor force, employment, unemployment, and unemployment rates for Louisiana parishes. 1993.

State of Louisiana, Department of Labor. "Employment and Total Wages Paid by Employers Subject to the Louisiana Employment Security Law, Third Quarter 1992", April 1993.

State of Louisiana, Department of Wildlife and Fisheries. Unpublished reports of the quantities and values of commercially harvested hides, pelts, and meats.

State of Louisiana. Louisiana State Planning Office. Unpublished provisional estimates of land and water acreage in Louisiana parishes, coded by usage or type. 1980.

Stein, Dina. American Petroleum Institute. "International Management of Wetlands". Discussion Paper #073. Washington, D.C. 1992.

U.S. Department of Commerce, Bureau of the Census. *1990 Census of Population and Housing.* "Summary of Population and Housing Characteristics, Louisiana". 1990 CPH-1-20. Washington, D.C. 1991.

U.S. Department of Commerce, Bureau of the Census. *1980 Census of Population.* "Number of Inhabitants, Louisiana". PC80-1-A20. 1982.

U.S. Department of Commerce, Bureau of the Census. *1987 Census of Manufactures, Louisiana.* Geographic Area Series. Washington, D.C. 1990.

U.S. Department of Commerce, Bureau of the Census. *1987 Census of Wholesale Trade, Louisiana.* Geographic Area Series. Washington, D.C. 1989.

U.S. Department of Commerce, Bureau of the Census. *1987 Census of Service Industries, Louisiana.* Geographic Area Series. Washington, D.C. 1989.

U.S. Department of Commerce, Bureau of the Census. *1987 Census of Retail Trade, Louisiana.* Geographic Area Series. Washington, D.C. 1989.

U.S. Department of Commerce, Bureau of Economic Analysis. "Survey of Current Business". Washington D.C. 1992.

U.S. Department of Commerce, Bureau of Economic Analysis. *1990 BEA Regional Projections to 2040.* Vol.2: Metropolitan Statistical Areas. Washington, DC: U.S. Government Printing Office. 1990.

U.S. Department of Commerce, Bureau of Economic Analysis. "County Projections to 2040 Louisiana". Unpublished revisions to data in the BEA Regional Projections to 2040, Vol. 2 referenced above reflecting the *1990 Census of Population and Housing* and detailing data for individual parishes, including data for all individual parishes in the state of Louisiana. 1992.

U.S. Department of Commerce, National Marine Fisheries Service, *Fisheries of the United States, 1991* and previous annual reports from 1978 through 1992.

BIBLIOGRAPHY FOR EIS

U.S. Department of Commerce, National Marine Fisheries Service, New Orleans Office. Published but largely unpublished preliminary annual reports of pounds and value of commercial fish and shellfish landings for individual species for the period 1060 through 1991.

U.S. Department of Energy, Energy Information Administration. *Natural Gas Annual, 1991.* DOE/EIA-013(91). Washington, D.C. 1992.

U.S. Department of the Interior, Bureau of Mines, Mineral Industry Services. *The Mineral Industry in Louisiana in 1992.* Washington, D.C. 1993.

U.S. Department of the Interior, Bureau of Mines. *Bureau of Mines Minerals Yearbook.* Preprint series of Vol. 2. Washington, D.C. 1958 through 1975.

U.S. Department of the Interior, Minerals Management Service. *Federal Offshore Statistics: 1991.* OCS Report MMS 92-0056. 1992.

Ward, John M. *Feasibility Study of Vessel Entry and Exit Behavior Using the Gulf of Mexico Shrimp Fishery Data Set from 1965-80.* U.S. Department of Commerce. National Marine Fisheries Service. NOAA Technical Memorandum NMFS-SEFC-231. Southeast Regional Office. St. Petersburg, Florida. 1989.

K - Prime and Unique Farmlands

The prime farmland designation reflects a current or potential land use. In Louisiana's coastal parishes, prime farmlands are comprised largely of the soils and areas that comprise distributary ridges (e.g., Bayou Lafourche, cheniers).

There are 1,051,900 acres of prime farmland located in the 13 coastal parishes (Table K1). Vermilion Parish has the largest acreage (275,000) while St. Bernard (18,400) has the smallest acreage.

Some areas designated a prime farmland may be comprised of hydric soils. As such, some prime farmland areas may be wetland areas or exhibit some wetland attributes.

There is little likelihood that prime farmlands would be impacted by marsh management activities because the kinds of wetlands that are the subject of the PMMEIS are not the kinds that would be typically classified as prime farmlands. Nonetheless, some marsh management efforts are designed to affect the quantity and quality of the vegetated surface and control water levels. Such management may elevate the grazing potential of the managed area. By moving cattle grazing operations to managed marshes, prime farmlands formerly dedicated to grazing become available for alternative agricultural uses.

The actual relationship between a specific marsh management plan and prime and unique farmlands is characterized and evaluated as part of each and every analysis of requested permits performed by the NOD in conjunction with marsh management.

# L - Cultural Appendix

FILE/PROGRAMA

**DRAFT**
SEVERAL SECTIONS TO BE COMPLETED

CELMN-PD-RN (1165-2-26a) 29 May 95

MEMORANDUM FOR: CELMN-PD-RS

SUBJECT: Input for Marsh Management Programmatic EIS

Enclosed please find the preliminary information on Cultural Resources for the above referenced project.

PRESENT COASTAL ZONE CONDITIONS

Cultural Resources
The coastal wetlands of Louisiana are known to contain numerous historic and prehistoric archeological sites. These sites span the human occupation sequence of the state and represent Louisiana's long cultural heritage. Over twenty four hundred archeological and historical sites have been recorded for the ten identified Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) river basins. In addition to these sites, more than two hundred historic properties are listed on the National Register of Historic Places.

The prehistoric sites in the area are predominantly Indian shell middens situated along the natural levees of rivers and bayous and surrounding shorelines of the numerous coastal lakes. Archeological evidence indicates that these prehistoric Indians gathered both freshwater and brackish water shell fish available in the nearby waters. These sites were habitation areas as well as camp sites for shellfish processing. Numerous mound sites also exist on the higher ground in the coastal zone. Salt domes and cheniers are another favorite habitation area...

Historic sites in the coastal area date as far back as colonial times. These sites are usually located along the natural levees of bayous and rivers. These waterways served as transportation routes in the past and continue to be used for commerce even now. Types of historic sites include domestic buildings, boat landings, hunting and fishing camps, farms, plantations, commercial and industrial sites as well as shipwrecks, military fortifications and so forth.

<MORE DETAIL ON TYPES OF SITES AND OCCUPATIONAL SEQUENCES>

Many of these archeological sites and historic properties have been determined eligible to or listed on the National Register of Historic Places. The National Register of Historic Places was

established in 1966 by the National Historic Preservation Act (NHPA). The National Register is used as a key management tool for cultural resource management. National Register criteria for significance is used to examine all cultural resources in determining if a site is significant or not significant. All federal agencies having direct or indirect jurisdiction over federal, or federally assisted, permitted, or licensed activities have to take into account the effects of the proposed undertaking on cultural resources.

The National Historic Preservation Act of 1966 (NHPA) as amended was enacted to ensure that the country's historic resources would be considered in any federal project and federally assisted or permitted projects. Section 106 of this act states that all federal agencies "take into account" how their proposed actions would affect any historic or archeological property. A federal undertaking includes a wide variety of actions such as construction activities, rehabilitation and repair projects, permits, and demolition to name a few. Federal agencies are required to consider alternatives to avoid, mitigate, or minimize adverse impacts on historic properties (any prehistoric or historic district, site, building, structure, or object eligible for inclusion in the National Register). The federal agency involved in the proposed project is responsible for initiating and completing the Section 106 review process. The federal agency confers with the State Historic Preservation Officer (an official appointed in each state to administer the National Historic Preservation Program) and the National Advisory Council on Historic Preservation.

There are five basic steps in the Section 106 review process. These are:

1. Identify and Evaluate Properties;
2. Assess Effects;
3. Consultation;
4. Council Comment; and
5. Proceed

Step 1 <u>Identify and Evaluate Properties.</u> The lead federal agency is responsible for reviewing all available documents, maps and cultural resource databases to determine the level of cultural resource survey coverage as well as the presence or absence of prehistoric and/or historic resources in a project area. If survey coverage is non-existent or additional information is needed, the federal agency may conduct additional work. All cultural resources located in a project area are then evaluated for significance using National Register of Historic Places (NRHP) criteria. The federal agency and the State Historic Preservation Officer decide whether the properties are eligible for listing to the National Register.

Step 2 <u>Assess Effects.</u> Following identification and evaluation of cultural resources, the federal agency is responsible for determining the effect of its proposed action/activity on significant cultural resources. This determination of effect is

made in consultation with the State Historic Preservation Officer (SHPO).

There are three possible determinations:
a. No effect. This determination is made when the agency's proposed action will have no effect on cultural resources in the project area. The agency notifies the SHPO. If the SHPO does not object, the project may proceed.

b. No adverse effect. In this case there could be an effect to a cultural resource, but the effect is not harmful. The agency obtains SHPO concurrence and submits to the Advisory Council a determination of no adverse effect. The project may proceed.

c. Adverse effect. This is when it has been determined that the proposed action could have a harmful effect on a cultural resource. The agency is required to begin the consultation process.

Step 3. <u>Consultation.</u> The purpose of consultation is to find acceptable ways to reduce the harm to a cultural resource so the project may proceed. This may involve such measures as avoiding the cultural resource or mitigating the adverse effect. The federal agency and the SHPO are the consulting parties. The Council determines their level of involvement in this step. When the consulting parties agree upon steps to avoid or mitigate harm they sign a Memorandum of Agreement (MOA). If an agreement cannot be reached, the federal agency may submit documentation to the Advisory Council for comments.

Step 4. <u>Council Comment.</u> After consultation, the federal agency submits the signed MOA to the Council for review. The Advisory Council has the option to sign the MOA, request changes or chose to issue written comments on the proposed activity. If an agreement was not reached in consultation by the SHPO and the agency, the council will submit written comments to the agency regarding the proposed action.

Step 5 <u>Proceed.</u> If agreement was reached and a MOA was signed then the agency can proceed with the project. If an MOA was not signed then the Federal Agency must take into account the Council's written comments.

Each year numerous project permit requests are submitted to the Regulatory Division of the U.S. Army Corps of Engineers. The New Orleans District recognizes its responsibility regarding cultural resources management and the Section 106 process of the National Historic Preservation Act. All COE permit requests are mailed to the State Historic Preservation Office. If the Environmental Review Coordinator in the Louisiana State Historic Preservation Office feels that a survey is necessary or some other action must be taken, than a letter is sent with the review results.

The Natural\ Cultural Resources Section of the U.S. Army Corps of Engineers, New Orleans District has been coordinating with the State Historic Preservation Office regarding cultural resources investigations associated with various projects and Section 106 requirements.The Section 106 process can sometimes be very lengthy and complicated.

The New Orleans District has surveyed project lands for cultural resources for over twenty years now. The surveys were conducted prior to construction of main line levees, hurricane protection levees, dredging, erosion control programs, Coastal Wetlands Planning, Protection and Restoration Act projects. These surveys have produced large quantaties of data about archaeological/ historical sites including site maps, reports, artifact catalogs and so forth.

Archaeological Resources in the Coastal Zone has been entered into the the Cultural/Natural Resources Analysis Section computerized working database program known as the Cultural Resources Information System (CRIS). Under an agreement with the State Historic Preservation Office, Division of Archaeology their archaeoloical site file data was entered into a Dbase 3 format in 19--. This computerized database is now being updated.

CULTURAL RESOURCES INCLUDING NATIONAL REGISTER SITES

Various marsh management projects may or may not have an adverse impact on cultural resources. Each proposed project action must be examined on a project by project basis. Cultural resources evaluations are made on site specific as well as project specific information and plans. Maps indicating the location of cultural resources and cultural resources survey coverage are checked against the location of the proposed marsh management projects.

Several cultural resources investigations have been conducted in the coastal zone which have identified numerous archeological and historical sites. These surveys, however, only cover a small percentage of the coastal zone. Many more surveys need to be conducted to determine the presence or absence of significant cultural resources.

A cultural resources evaluation of each of the proposed marsh management projects will need to be conducted as soon as an permit application is received in order to avoid project delays. In some cases project designs could destroy, damage, or obscure archeological sites by construction activities. Cultural resource investigations will identify any significant cultural resources which may be at risk and allow time for changes to the project designs to avoid adverse impacts. The site specific nature of these resources demand this type of action. In some instances the proposed action may actually help to preserve and protect cultural resources. Coastal lands are eroding rapidly and the protection of these lands by the various marsh management projects may protect

sites in the long run by stopping or slowing down land erosion.

Three major types of actions predominate these proposed erosion measures. These are: 1.) sediment diversion or re-deposition, 2.) dredging of some type, and 3.) building of structures. Sediment diversion may or may not have an adverse impact on historical or archeological sites. Increased sediment flow may cause a direct impact on any site in the immediate area, while in some cases it could provide sediment around an area acting as a buffer to further erosion. Depositing sediment on top of a known site can change the environment in which a site has survived. This may or may not be an adverse impact. Dredging a waterway could impact any prehistoric or historic shipwreck in the area. Submerged cultural resources surveys are conducted in areas with a high probability of containing shipwrecks. Construction of erosion devices such as weirs or dikes, or the building or removal of canal banks can adversely impact any prehistoric or historic site in the immediate impact area. In all cases these actions need to be examined on a project by project basis.

<TABLE LIKE THIS CAN BE PREPARED TO SHOW MARSH MANAGEMENT ACTIONS>

| ALTERNATIVE PROPOSED | CONTROL MEASURE | CULTURAL RESOURCE | POSSIBLE IMPACT |
|---|---|---|---|
| MARSH MANAGEMENT | | | |
| HYDROLOGIC RESTORATION | | | |
| OUTFALL MANAGEMENT | | | |
| SEDIMENT DIVERSION | | | |
| FRESHWATER DIVERSION | | | |
| MARSH CREATION WITH DREDGED MATERIAL | | | |
| BARRIER ISLAND RESTORATION | | | |
| SHORELINE EROSION CONTROL WITH STRUCTURES | | | |
| SHORELINE EROSION CONTROL WITH VEGETATION | | | |
| TERRACING | | | |
| SEDIMENT TRAPPING | | | |
| HERBIVORE CONTROL | | | |

SIGNIFICANT ITEMS AND EFFECTS OF MARSH MANAGEMENT ACTIONS. Actions such as plugging or filling canals, or removing canal banks or causing gaps to increase sheet flow into an area could impact significant....ADD......

As a result of coordinationin the past, such as the one developed by the Natural and Cultural Resources Analysis Section for the CWPPRA Task Force, an memorandum of agreement with the State Historic Preservation Office was established which outlines procedures to follow in meeting cultural resource compliance. The Colonel acting on behalf of the Task Force and the State Historic Preservation Officer have signed this document. The Task Force composed of both state and federal agencies has agreed to follow the procedures as stated in ....... ???????

SUMMARY BY BASIN

| | NAME OF BASIN | CULT. RES SURVEYS | ARCH. SITES | NATIONAL REGISTER PROPERTIES |
|---|---|---|---|---|
| 1 | Calcasieu\Sabine 2 parishes | 109 | 263 | 5 |
| 2 | Mermentau 2 parishes | 83 | 203 | 2 |
| 3 | Teche/Vermilion 3 parishes | 133 | 347 | 26 |
| 4 | Atchafalaya 2 parishes | 90 | 212 | 24 |
| 5 | Terrebonne 5 parishes | 259 | 764 | 40 |
| 6 | Barataria 8 parishes | 422 | 873 | 38 |
| 7 | Breton 2 parishes | 111 | 294 | 7 |
| 8 | Pontchartrain 10 parishes | 493 | 1056 | 134 |
| 9 | Mississippi R. Delta 1 parish | 76 | 152 | 4 |

DISCUSS
Problem of# of surveys being duplicated since data is keep by paris and not by basin at the State Historic Preservation Office counts by parish

1. Calcasieu /Sabine Basin

2. Mermentau Basin

3. Teche/ Vermilion

4. Atchafalaya Basin

5. Terrebonne Basin

6. Barataria Basin

7. Breton Basin

8. Pontchartrain Basin

9. Mississippi River Delta

Approximately 30 man hours has been expended on this project due to lack of funds for this adspect of the EIS and my prsent work load...as soon as more funds are available this can be completed

General information on the number of cultural resources in the area and a listing of all cultural resources surveys by parish has been gathered.

Future work needed to be done includes a more detailed evaluation of the types of cultural resources in the ten basins; types of impacts expected from marsh management projects which could affect cultural resources. Recommendations will be presented which could better provide data for National Historic Preservation Act compliance, as well as other environmental compliance such as NEPA.

NO ACTION ---FUTURE CONDITIONS WITHOUT MARSH MANAGEMENT EFFORTS
Land surfaces in the coastal zone will continue to erode and in some instances could cause loss of cultural resources. Many of these fragile archeological sites in the wetlands may be adversely impacted by destructive natural forces such as subsidence and erosion. Other destructive forces attributed to man such as wave action from passing ships, or construction activities will also continue to destroy cultural resources in these areas.

M - Management Structures: A overview of the design, impacts and effects of several water control structures used for marsh management/hydrological restoration

There exists an impressive arsenal of structures and operational options managers can use to affect the hydrologically-influenced attributes that influence the growth and vigor of marsh vegetation and mash-dependent animal species (Broussard, undated). Managers can affect where water comes from or goes, how quickly or slowly it moves over and through the marsh, how deep or shallow water levels get over vegetated marsh surfaces, marsh soil profile and in ponds, and what it carries entering or leaving a marsh (Broussard, Undated).

Management structures typically effect a suite of hydrologically-influenced attributes, some by design some unavoidably. Thus, the hydrologic effects of the structures selected for a given management effort seldom correspond perfectly with management needs. The difference can be the basis for the manager contemplating what, if any, secondary interests can be addressed to what degree with what, if any, additional effort. The difference can also have associated social and economic implications as well as other biological consequences.

Spicer, Clark and deMond (1986) and Broussard (Undated) discuss engineering and construction details of several commonly used water control structures for managing marshes. Information about some of the environmental design considerations (Spicer, Clark and deMond 1986) and water management schedules (Broussard, Undated) associated with several commonly used structures is also available. Broussard (Undated) also briefly discusses some of the structure variations (Broussard, Undated - Chapter 9: New Engineering Techniques). Rogers, Herke and Knudsen (1987) focus on some of the comparative hydrologic and biological effects of two structures.

M.1. Plugs/Levees

Levees and plugs serve nearly identical hydrologic functions, the principal one being to create an impermeable barrier. By perceiving a plug as a very short levee or a piece of a levee, then what follows could apply to both plugs and levees.

Constructed of wood, metal sheet pile, shell, or some combination thereof, plugs are designed to permanently prevent the exchange of water (Broussard, undated). The crest of these structures is typically at or above marsh level. They are used independently or in conjunction with other structures.

Once installed, a plug will influence water levels and other attributes without any need for further adjustment (Broussard, undated). Provided water levels don't overtop

the structure, the degree of influence is constant and absolute.

The desired impact of a plug on the hydrology of a managed area is to create an impermeable barrier between the managed area and the surrounding marsh system such that the hydrologically-driven rhythms, dynamics and chemistry of the managed area can be controlled by actions taken where the managed area communicates with the surrounding marsh system.

The desired management effects are to: 1) create the opportunity to manage at a distant location; 2) preclude the intrusion of unwanted outside influences at a particular location; 3) deflect hydrologically-driven influences to another area; and/or, 4) serve to discourage entry into managed areas.

Often unintended but associated biological effects of management include: 1) an instantaneous reduction of estuarine fisheries access (due to the physical presence of the structure); 2) use by nontargeted bird species and animal species during periods of irregular water levels (e.g., refugia during high water events); 3) congregate fish; and, 4) block the access of the public to the managed area. Reduction of these effects can be the subject of mitigation.

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduced access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives, and/or 2) congregate fishermen, which is a commonly known effect. Reduction of these effects can be the subject of mitigation.

Very infrequently is a plug used as the only water control structure for management any more. The norm is to use plugs in conjunction with other kinds of water control structures.

The biological effects and management effectiveness of plugs, when used in combination with other structures, have not been independently or comprehensively studied and documented quantitatively. As such, NOD concludes that effects and effectiveness have been presumed largely by extension of our understanding of plugs when used singularly.

The contribution plugs make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a plug when used in combination plans probably arises more from the management flexibility the other structures lend to

the plan. Projections of "futures" conditions will reflect this assumption.

M.2. Rock Weirs

Constructed of large-sized rock, these weirs are designed to dampen the rate of and volume of water exchanged between managed and unmanaged areas much like a fixed-crest weir (Broussard, Undated). However, water moves through the entire profile of the structure via the spaces between rocks. The top of these structures can be above or below marsh level, but typically is set at or just below marsh level (Broussard, Undated).

Once installed, a rock weir influences water levels and other hydrologically influenced attributes without any need for further adjustment. However, the degree of influence is not constant because water is continuously exchanged throughout the water column between the managed and unmanaged areas.

The desired impact of a rock weir on the hydrology of a managed area is to slow the rate of and reduce the volume of water exchanged between managed marsh and the surrounding marshes. In a sense it's designed to leak in both directions, or act as a filter. Thus, the rhythms, dynamics and chemistry of the surrounding marshes area will be "filtered" through the rock weir but will still be expressed, although in a diminished manner, primarily in the portions of the managed area nearer the structure. Stated more formally, rock weirs can be used to: 1) dampen the intrusion of unwanted outside influences at a particular location (e.g., primarily the erosive effect of water movement, secondarily salinity); 2) allow for a limited introduction of desirable hydrologically-influenced attributes (e.g., nutrient, mineral and detrital exchange); and/or, 3) partially deflect hydrologically-driven influences to another area.

The foremost desired management effect is to foster the movement of fisheries between the managed and unmanged areas. Secondary desired management effects include: 1) improve the growth conditions for submerged aquatic vegetation (by reducing the amounts of suspended materials and salinity introduced into the managed area); 2) preserve stands of submerged aquatic vegetation (by forestalling the onset of the stresses induced when ponds drain by prolonging the time it takes for ponds to rain or fill in response to winds or tidal action); 3) serve to discourage human entry into managed areas; and/or, 4) possibly retain enough water in the managed area to facilitate recreational and commercial activities.

Often unintended but associated biological effects of

management include: 1) an instantaneous reduction of estuarine fisheries access (due to the physical presence of the structure); 2) use by nontargeted bird and animal species during periods of irregular water levels (e.g., refugia during high water events); 3) congregate fish; 3) progressively isolate managed area (because spaces between rocks become clogged); and/or, 4) block access by the public to managed area.

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduced access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations are feasible design modifications relative to the management objectives; 2) congregate fishermen; and/or 3) block access by the public to managed areas.

Rock weirs have not been used extensively. Marsh soils don't readily support their great weight (Broussard, Undated), adding appreciably to maintenance costs. Generally, rock weirs have been used as the only water control structure. There seems to be a great potential to investigate where they have utility, and what relationship their may be between marsh elevation changes, changing water levels, and the hydrologic impacts. As such, NOD concludes that the effects and effectiveness of rock weirs have not been adequately documented but, of necessity, presumed based largely on professional insights driven by the results of very limited studies (    ) and fewer field applications. As such, NOD concludes that effects and effectiveness should be presumed with great caution, but because they pass water throughout the water column, could be compared with slotted weirs, at least in that simple context.

The contribution rock weirs could make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a rock weirs probably arises more from the reduced hydrologic and fisheries impacts that are associated with those structures. Projections of "futures" conditions will reflect this assumption.

M.3. Fixed-crest weir

Fixed-crest weirs, essentially a low-level dam set at an unadjustable elevation (historically six inches below marsh level), are strategically placed in surface waterways or embankments (Broussard, Undated). Once installed, the weir will influence water levels and other attributes without any need for further adjustment (Broussard, undated). However, the degree of influence is not necessarily constant. So long as water levels remain above the crest elevation (or the area is not otherwise hydrologically isolated), the

managed area's rhythms and dynamics would be nearly identical with those in the surrounding marsh. Once water levels fall below the crest, the managed area shows progressively less to very little no linkage with the rhythm, dynamics and chemistry of the surrounding marsh, especially if the area is semi-impounded (Herke, ).

The desired impacts of a fixed-crest weir on the hydrology of a managed area are to retain a minimum amount of water in ponds even when water levels outside the managed area are lower or rise suddenly because of vessel passage, reduce surface water salinities, reduce water exchange velocities and reduce suspended sediments in the water column (Broussard, undated).

The desired management effects are to: 1) facilitate the growth of submerged aquatic vegetation (through the reduction of suspended materials and salinity reduction); 2) preserve stands of submerged aquatic vegetation (by precluding the stress induced as ponds drain and fill in response to winds or tidal action); and, 3) retain enough water in the managed area to facilitate recreational and commercial activities.

Often unintended but associated biological effects of management include: 1) an immediate reduction of estuarine fisheries access (due to the physical presence of the structure); 2) slow to materialize but eventually measurable shifts to a fresher fisheries community (again due to the isolating effect of the structure); 3) higher use by nontargeted bird species during periods of low or no water in surrounding marshes (Chabreck, 19 ; Breininger and Smith, 1990); 4) possibly even a slow to materialize but eventually measurable shift to a more flood tolerant emergent marsh plant species community ( ); and, 5) congregate fish.

Sometimes unintended but associated and unavoidable social and economic effects are to: 1) immediately reduced access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives, and/or 2) congregate fishermen, which is a commonly known effect. Reduction of these effects can be the subject of mitigation.

Very infrequently is a fixed-crest weir used as the only water control structure for management any more. The norm is to use fixed-crest weirs in conjunction with other kinds of water control structures.

A biological effect that is being investigated is what effect fixed-crest weirs, usually in combination with other structures, have on sediment dynamics in particular, but

marsh floor elevations in general, and, thus, the relationship between marsh elevation changes and changing water levels.

The effectiveness of fixed-crest weirs at achieving management goals when used singularly is variable.

The biological effects of and management effectiveness of fixed-crest weirs (to include boat bays), when used in combination with other structures, have not been quantitatively studied and documented. As such, NOD concludes that effects and effectiveness have been presumed largely by extension of our understanding of weirs when used singularly.

The total contribution fixed-crest weirs make to increasing or reducing social and economic effects when used in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a fixed-crest weir used in combination plans probably arises more from the management flexibility the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

M.4. Verticle-slotted weir

Once installed, a vertical-slotted weir will influence water levels and other attributes without any need for further adjustment (Broussard, Undated; Rogers, Herke and Knudsen, 1987). However, the degree of influence is not constant. So long as water levels remain above the crest elevation, the managed area exhibits rhythms, dynamics and water chemistries nearly identical with those in the surrounding marsh. Once water levels fall below the crest, however, the rhythms and dynamics of the managed area still exhibit the rhythms and dynamics of the surrounding marsh but to a diminished degree and slightly out of phase (Rogers, Herke and Knudsen, 1987).

The desired impacts of a fixed-crest weir on the hydrology of a managed area are to: 1) increase the linkage between the managed and unmanaged marshes; 2) retard but not necessarily prevent the evacuation of water from ponds as part of rhythms and dynamics of the marsh surrounding marsh system; 3) reduce water exchange velocities; and, 4) reduce suspended sediments in the water column (Broussard, Undated).

The overriding management effect desired is to facilitate and promote the freer exchange of fisheries species into and out of managed areas (by eliminating the truncation of the rhythms and dynamics of the marsh system caused by the solid wall of a traditional fixed-crest weir. In a test

situation, a 6" verticle slotted, fixed-crest weir did have significantly less adverse effect on fisheries (Rogers, Herke and Knudsen, 1987). Although unquantified, a slotted weir structure should be somewhat less effective (than a fixed-crest weir) at: 1) fostering the growth of submerged aquatic vegetation (through suspended materials reductions); 2) preserving stands of submerged aquatic vegetation (by reducing the potential stress associated with ponds draining and filling in response to winds or tidal action) barring prolonged periods of low water in the surrounding marshes; and, 3) retaining enough water in the managed area to facilitate recreational and commercial activities.

Often unintended but associated effects of management with vertical-slotted weirs include: 1) a fairly quickly and measurable suppression of fisheries (still related to the constriction imposed by the structure), but less than associated with a fixed-crest weir; 2) a salinity response characterized by a fairly quickly and measurable reduction of salinity variation accompanied, however, by a slight increase in average salinity, that virtually disappear when water levels overtop the structure and/or seasons move from winter into summer (unexplained); and, 3) no measurable effect on water temperatures. No data are available directly linking use by nontargeted bird species during periods of low or no water in surrounding marshes or how emergent vegetative species respond in either the short or long-term to the independent hydrologic effects of slotted-weirs.

Sometime unintended but associated and unavoidable social and economic effects are to: 1) immediately reduce access by the public to a formerly accessible marsh area, unless some provision for lower weir crest elevations (or boat bays) are feasible design modifications relative to the management objectives; and/or, 2) congregate fishermen.

Very infrequently is a vertical-slotted fixed-crest weir used as the only water control structure for management any more. The norm is to use one or more in combination with other kinds of water control structures when their use won't compromise the overall management objective.

The effectiveness of fixed-crest weirs at achieving some management goals when used singularly is based solely on the work by Rogers, Herke and Knudsen (1987).

The biological effects of and management effectiveness of fixed-crest weirs (to include boat bays), when used in combination with other structures, have not been quantitatively studied and documented. The range of biological effects associated with using verticle-slotted fixed crest weirs have yet to be quantified. What effect they have singularly, in combination with other structures,

on sediment dynamics in particular, but marsh floor elevations in general, and, thus, the relationship between marsh elevation changes and changing water levels, remain fertile areas for investigation. As such, NOD concludes that effects and effectiveness have been presumed largely by professional insight driven extensions of our understanding of weirs when used singularly.

The contribution fixed-crest weirs make to reducing social and economic effects when used singularly or in combination with other types of structures is unknown. However, any reduction of adverse social and economic effects related to the use of a verticle-slotted fixed-crest weir used in combination plans probably arises as much from the fisheries effects reductions as from the management flexibility the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

M.5. Variable-crest weir, mated with flap-gated culvert(s)

The variable crest weir was adapted to management of Louisiana marshes by NRCS during the late 1970's.

A variable crest weir is a dam whose elevation can be periodically raised or lowered at the discretion of the manager so that the degree of control on water levels and other hydrologically-driven attributes can be maintained at some relatively constant level regardless of the environmental variation. The lowest weir crest elevation is often lower than most pond substrates in the managed area, allowing the exposure of as much pond substrate as possible (Broussard, undated).

Upon installation, or as a retrofit, the variable crest weir can be mated with a flap-gated culvert. The culvert can have one flap-gated end that discharges to the surrounding marsh, or it can have flap-gates on both ends, to provide maximum management capability with just one structure (Broussard, Undated). The resultant structure can be operated as a fixed-crest weir {by setting the weir crest at the appropriate level and locking open the flap(s)} or it can be configured to only discharge water from the managed area (by unlocking the outside flap gate, locking open the inside flap gate and lowering the weir crest), thus lowering water levels in the managed area to levels lower than in the surrounding marsh.

If configured in a fixed-crest mode, the degree of influence is not constant and changes in proportion to the amount of variation in the environment. More typically, the structure is configured to operated according to a management-related schedule. When operated in this mode, the degree of influence can be kept constant or adjusted in any proportion to the amount of environmental variation wishes to be

communicated to and expressed within the managed area, to include intentionally isolating the managed area from the dynamics, rhythms and chemistry of the surrounding marsh.

The desired impacts of a variable crest weir fitted with a flap-gated culvert on the hydrology of a managed area are the capability, at any time of any year, to: 1) fairly precisely manipulate (rather than just dampen) water levels (quantity); 2) precisely control flooding duration; and, 3) affect the water quality by configuring the structure to admit as much or as little water from the surrounding marsh.

In addition to the desired management effects of fixed crest weirs, the desired management effects of variable-crest weirs mated with flap-gated culverts are: 1) facilitating an even more extensive and vigorous growth of submerged aquatic vegetation (through the firming of exposed substrates and tighter salinity and water level control); 2) affecting a suite of life requisite factors by artificially creating and sustaining a relationship between water levels and exposable marsh substrates (that would otherwise be inundated) conducive to the growth of emergent marsh plant species (through scheduled water level reductions typically once every three years); 3) the ability to allow fishery ingress and egress for limited periods without compromising the overall management goal(s) {by briefly locking open the flap gate(s) and lowering the weir crest for ingress, and lowering the crest and unlocking the flap-gate(s)} for egress; and, 4) the flexibility to address subordinate interests (by creating the potential to modify the composition of the marsh plant community).

In addition to the unintended but associated biological effects associated with fixed-crest weirs, during prolonged periods of generally low fresher water availability (typically July through October), some managers must decide whether the risks of introducing only enough saltier water from the surrounding marsh into the managed area (to prevent desiccation of the vegetation and drying of the substrate) are greater than waiting for a storm to introduce fresher water.

The unintended but associated and unavoidable social and economic effects of managing with a variable-crested weir mated with a flap-gate are very similar to those enumerated for a fixed-crest and verticle-slotted weir. Notably, fishermen generally have learned that these structures can be fished easily and very efficiently at certain times of the year. A few fishermen may apply that knowledge in the extreme by fishing with nets very near to or affixing nets to the outside end of a culvert and configuring the culvert (and weir) to free flow, usually contrary to prescribed management settings. Left uncorrected, or if the structure was damaged and the situation can't be corrected by the

manager in time, the management effort could be compromised as well as creating the potential to damage the targeted marsh.

Because of the greater management potentialities created, managers are opting more often to use a variable crest weir mated with a culvert and flap-gate(s) in hydrologically discrete areas. Other structures may well be used in the management effort but largely in a supporting role. The capability to induce vegetation to grow on exposable substrates, in combination with the possibility that the growth and vigor of the native emergent vegetation is appreciably increased, provides the basis for the assertion that this form of management can reverse marsh losses (NRCS ).

The contribution variable crest weirs mated with a culvert and flap-gate(s) make to reducing social and economic effects when used singularly or in combination with other types of structures is unknown. To the contrary, there is a basis to argue that they heighten the potential for conflict between the landowners/leaseholders and components of the general public. However, any reduction of adverse social and economic effects the use of such management structures may cause when used in combination plans probably arises more from the impact reduction potentials the other structures lend to the plan. Projections of "futures" conditions will reflect this assumption.

The biological effects of and effectiveness of variable crest weirs mated with a culvert and flap-gate(s) have yet to be generally proven, have been ( ) or are being studied (Fina LaTerre, Rockefeller), are apparently presumed by proponents (largely based upon the high degree of management flexibility the use of such structures gives the manager and the notion that some degree of management will always be possible with such a structure) ( ) and questioned by those adversely effected ( ). Many aspects remain to be quantified but the pivotal biological question is what effect(s) such structures have singularly, or in combination with other structures, on the degree and rate marsh soil erosion can be slowed, stopped or reversed (such that marsh soils and elevations can be recreated and revegetated after being eroded). The pertinent social and economic questions are whether intensively managed areas will prolong and invigorate or hasten the decline of a struggling industry ( ). These have been and remain fertile areas for investigation and are the focal point of the social controversy surrounding marsh management.

NOD realizes that management undertaken principally with variable crest weirs mated with a culvert and flap-gate(s) can be an alternative to other structure choices for management. The effects and effectiveness of such

structures remain to be convincingly and comprehensively demonstrated. NOD recognizes the presumption by management proponents that such an approach can be made to work is largely based upon professional expectations based on accepted management theory. NOD recognizes that using such structures to effect impact intensive management on a large scale at this time should be undertaken only on an as needed basis. Only when the comprehensive ecological effects (biological, social and economic) are better understood and quantified will any inherent general utility this marsh management structure be fully appreciated.

M.6. General Limitations of All Structures

The best designed and operated management plan will be effective only within a portion of the environmental variation that controls the viability of Louisiana's coastal marshes. Seasonal rainfall shortages or excesses, tropical weather systems and subsidence are factors some individual managers are powerless to slow, stop or reverse but significantly effect how much or how little their management efforts can be expected to achieve.

N - Threatened and Endangered Species/Marine Mammals
(Reserved)